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**Perinatal PTSD trajectories in Pandemic exposed Pregnancies: Parenting and Child Development outcomes**

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*INTRODUCTION*

The theoretical premises on which this study is based belong to the Prenatal Maternal Stress (PNMS) research field, where it is highlighted the vulnerability of the prenatal period. Indeed, maternal mental health, in a period featured by significant individual and interpersonal transformations and reorganizations, has a well-recognized role in programming the obstetric outcomes and complications, as well as the growth and development of the fetus. In particular, our reflection focuses on perinatal maternal mental health, linked to different predictors and future outcomes.

Besides the relevance of the intrauterine environment highlighted by the PNMS perspective, also the general environment at a community and social level is crucial. In fact, if a vulnerability of maternal mental health is already registered during the perinatal period, others concurrent adverse life conditions could put it even more at risk. In this sense, the context of the Covid-19 pandemic, with its limitations and changes in perinatal care and routines, provided us a unique opportunity to detect any changes in the maternal psychological well-being. More specifically, the focus of our research is on perinatal PTSD, considering various risk factors and postpartum outcomes about parenting and child emotional and behavioral regulation.

The first chapter presents the theoretical framework of the study. Firstly, it is described the Fetal Programing Hypothesis and its neurobiological mechanisms which occur during pregnancy. Secondly, the period of pregnancy and transition to parenthood is analyzed in the context of the pandemic. In fact, the Covid-19, described as an additional stress source, introduces the PNMS in its various manifestations and with its short- and long-term consequences. Then, the focus moves to the perinatal PTSD psychopathology, by exploring more deeply its trajectory over time and the studied predictors. Lastly, the chapter ends with the description of the association of perinatal PTSD with negative parenting outcomes (i.e., parenting stress and parental burnout), as well as with infant's temperamental and behavioral problems, also highlighting the mutual influences between these different outcomes and the pathways through which they can develop.

The second chapter describes our research, which is part of a longitudinal study project implemented by the Department of Developmental Psychology and Socialization

(DPSS) of the University of Padua. This part represents a scientific paper where are precisely depicted the aims and the hypothesis, the procedure, the methods, and the materials employed. Secondly, the results obtained are described, and subsequently discussed. The final section of the chapter presents an overview of main strengths and limitations of the study and the conclusions and future research directions.

# CHAPTER 1. PRENATAL MATERNAL STRESS AND MATERNAL MENTAL HEALTH TRAJECTORIES

## 1.1. PREGNANCY

By choosing to consider the pregnancy condition we must notice that multiple factors are involved. These factors, in the perinatal period, which concern both the mother and the child, will be studied in the following paragraphs.

### 1.1.1. Fetal Programming Hypothesis

The intrauterine environment is the very first development context for the fetus, and its relevance was initially highlighted by David Barker in the 1980s, who, in the theoretical frame of epidemiological studies, points out the association between low weight at birth and coronary disease in adulthood, which led to the "*fetal programming hypothesis*" (or "*fetal origins of adult disease hypothesis*"; Barker, 1994). Fetal programming refers to the process by which an environmental information, stimulus, or insult during a vulnerable developmental period (like the gestational one for the fetus) is crucial for short- and long-term health outcomes, which sometimes are permanent (Barker, 1998; Kuzawa, 2005). In fact, concerning prenatal maternal malnutrition, low birthweight, and diseases in adulthood (such as cardiovascular disease, type 2 diabetes, and osteoporosis), Hales and Barker (1992) proposed the "*thrifty phenotype hypothesis*", which claims that health issues in offspring are the result of a fetal adaptation to an altered supply of nourishment (caused by maternal malnutrition, and/or other maternal/placental abnormalities) in order to survive in a lacking intrauterine environment. In this reasoning, also timing of exposure to a teratogenic agent, and the duration of the same, are relevant factors in determining the effects of programming (Davis & Sandman, 2010; Davis, Glynn, Waffarn, & Sandman, 2011). It means that, since the fetal nervous system follows a precise and specific sequence of development, the effect of the same teratogenic agent (which can result in an alteration and remodeling of brain functions and structures) will have different implications for different domains depending on the gestational period at which the exposure happens (Kinney, Miller, Crowley, Huang, & Gerber, 2008; Sandman, Glynn, & Davis, 2016).

Trying to understand the underlying mechanisms of fetal programming, Gluckman, Hanson, and Beedle (2007) have extended Barker's hypothesis. Indeed, Gluckman et al. (2007) agree with Barker's perspective of developmental plasticity, and, by consequence, with the fact that the fetus, in adverse conditions like those mentioned above, deploys "*immediately adaptive response*" to environmental demands (Lewis, Austin, Knapp, Vaiano, & Galbally, 2015) (which can be reversible or not, depending on the persistence of the environmental change) to improve its chance of survival. These immediate alterations, in developmental patterns in early stages of life, ensure short-time survival, but the same alterations could represent potential disadvantages in later environment (Gluckman et al., 2007). But these authors go beyond this, proposing the "*predictive adaptive responses*" (Gluckman, Hanson, & Spencer, 2005), that is predictive adaptation to expected future environments (Lewis et al., 2015), referring to the fact that some of these alterations can also have an adaptive advantage delayed, but only if the prevision is correct. This developmental pathway follows the "*match – mismatch*" paradigm, which states that if there is correspondence between the predicted and actual postnatal environment, the risk of disease will be lower, otherwise when it is mismatched the risk will be higher (Bateson et al., 2004; Gluckman et al., 2007).

From these theoretical bases it has been developed, in the 1990s, the research approach of the "Developmental Origins of Health and Disease" (DOHaD; Barker, 2004). The conceptual basis of DOHaD (Barker, 2004) rests on the abovementioned evolutionary and developmental notions. In fact, this theoretical perspective starts from the major fetus plasticity and its abilities to use different mechanisms to adapt to the intrauterine environment, as well as from the highest adaptation in evolutionarily predictable environment conditions (Lewis et al., 2015). So, the focus of this perspective is on the relevance of the antenatal experiences' quality, which may produce programming effects and may shape different health implications over a lifetime (Barker, 2012). In fact, since Barker hypothesis of fetal programming (Barker, 1994), evidences in this way have been collected. Beside the adverse pregnancy conditions detected by Barker (i.e., prenatal maternal nutrition), others prenatal factors have been related to adverse long-term outcomes in adulthood, like the exposure to environmental pollutants or toxic substances (Rodríguez-Rodríguez et al., 2018; Stieb, Chen, Eshoul, & Judek, 2012; Zammit et al., 2009), and maternal mental health (O'Donnell & Meaney, 2017;

Goodman et al., 2011; Schlotz & Phillips, 2009). The DOHaD model includes, indeed, maternal psychological distress in the concept of environmental exposure, by demonstrating that depression, anxiety and stress during pregnancy can affect fetal growth and, by consequence, perinatal and child development outcomes (O'Donnell & Meaney, 2017; Padula, Rivera-Núñez, & Barrett, 2020). By staying in the frame of mental health, we can mention some DOHaD studies which highlight how maternal distress during pregnancy has a real impact on different domains of a developing child (Glover, 2011), and it can affect the neural development of the child (Posner et al., 2016; Buss, Davis, Muftuler, Head, & Sandman, 2010), so much so that it has come to the idea that childhood neurodevelopment may have a fetal origin (Swanson & Wadhwa, 2008; Talge, Neal & Glover, 2007; Gluckman & Hanson, 2006).

In conclusion, in the current literature, the concept of Fetal programming and the concept of the "Developmental Origins of Health and Disease – DOHaD" focus more on the negative effects of prenatal maternal malnutrition, and, more recently, of prenatal maternal stress (PNMS) (O'Sullivan & Monk, 2020), considered both individually and in interaction (Lindsay, Buss, Wadhwa, & Entringer, 2019). We have therefore moved on to consider fetal programming not only in the medical field, but also in that of mental health and psychological well-being, which can influence fetal growth by producing negative behavioral, cognitive and emotional outcomes in the child (O'Donnell & Meaney, 2017).

## 1.2. ADVERSE PREGNANCY CONTEXT: NATURAL DISASTERS AND COVID-19 PANDEMIC

Environmental conditions, like natural disasters or the Covid-19 pandemic, represent independent prenatal stressors on the mother and her unborn child, reaching a condition where other alternative factors and explanation are minimized (Lequertier, 2018).

### 1.2.1. Natural Disasters as A Common Stress Condition in Pregnancy

A natural disaster represents a natural experiment for human studies that aim to investigate PNMS role in offspring development and maternal mental health. More

specifically, natural disasters offer the closest parallelism in human studies, of which is conducted in animal research, where stressors are external events that are controlled in terms of type, timing, duration, frequency, and intensity (DiPietro, 2004; King & Laplante, 2015). Animal studies, in fact, usually use a rigorous research design where they randomly assign pregnant animal to stress or nonstress conditions, which is not applicable in human studies for ethical reasons, limit that leaves unknown all those biopsychosocial mechanisms that could intervene in determining the consequences of PNMS (King & Laplante, 2015).

Precisely for this reason natural disasters are so important in this field: they allow to take advantage of the strengths of random assignment in human research on PNMS (King & Laplante, 2015). So, we can define a natural disaster as a discrete and external stressor, with a precise and easily identifiable timing (and independent of the control of individuals), exposing large numbers of pregnant women (at different gestational stages) to a severe and sudden-onset stressor, that affect women, pregnancies, and fetuses independently of socioeconomic, personality, and genetic backgrounds (Lequertier et al., 2019). Also, considering that, compared to animals, the human stress response is highly individual (falling on a continuum that goes from resilient and adaptive responses to significant psychiatric distress and poor functioning; Erickson, Morelen, & Muzik, 2022), natural disasters allow us to investigate both the objective exposure to the event, and the degree of subjective distress in response to it, which must be differentiated (King & Laplante, 2015).

Moreover, the examination of natural disasters and their consequences (i.e., potential influence on fetal development), is now more relevant than ever, considering climate change. In fact, climate change contributed to the recent increase in the frequency and intensity of natural disasters (Lafortune et al., 2021; Van Aalst, 2006).

### 1.2.2. Covid-19 Pandemic

The Covid-19 Pandemic refers to the diffusion of the disease caused by Covid-19 or Sars-Cov-2. Its symptoms in a prodromal phase are nonspecific, including fever, dry, cough, and malaise (Wang, Horby, Hayden, & Gao, 2020). The Covid-19 appears to be a new strain of coronavirus belonging to the same family of viruses that cause severe acute

respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). Some risk factors for severe illness were quickly identified, like older age and comorbidity (Cucinotta & Vanelli, 2020).

After the first cases in December 2019, registered in Wuhan, Hubei province, China, that became the center of an outbreak of pneumonia, the disease began to spread and become a worldwide concern. In fact, the WHO (World Health Organization) declared, on 30 January 2020, the Covid-19 epidemic situation in China an international public health emergency; on 28 February 2020 the global Covid-19 epidemic threat was raised at a "very high" level; on 11 March 2020 WHO Director-General called the spread of Covid-19 no longer a geographically confined epidemic, but a worldwide pandemic (Ministero della Salute, 2022). To give a glimpse on more recent data, in September 2022 there were, reported to WHO (2022), 603.711.760 confirmed cases of Covid-19, including 6.484.136 deaths.

At the beginning of the Covid-19 Pandemic the first goal was to prevent as much as possible transmission of the virus and to slow the rate of new infections. We can say that the pandemic has had an impact on different sphere of life, like the economy, global market, industries, agriculture, human health, health care, mental health, psycho-social etc. (Kumar & Nayar, 2021). This was a call for government and institutions to take action, but also for everyone, by taking everyday precautions like avoid close contact with people who are sick, and in general all the contacts which are non-essential, keep hands cleaned and sanified (by washing them properly and avoiding touching high-touch surfaces in public places), keep hands off eyes, mouth and nose (Cucinotta & Vanelli, 2020).

In fact, after the worldwide spread of Covid-19, restrictions have increased everywhere in the world, affecting people of all age groups irrespective of their socio-economic background (Singh et al., 2022). One of the prevention actions to reduce the spread of the virus, as above mentioned, are the "stay at home" and "social distance" measures (Hessami, Romanelli, Chiurazzi, & Cozzolino, 2020). And by focusing on the psychological impact of quarantine, the WHO (2020) highlights how this could provide an impact on the degree of fear, worry and concern (in population in general and among some particular groups, like those at higher risk of severe illness for older age or

comorbidity), and it could affect usual activities, routines, and livelihoods that can, by consequence, lead to a higher risk of increase in anxiety, depression, insomnia, alcohol and drug use and suicidal behavior (increase also due to issues of service access and continuity for people with developing or existing mental health conditions). In a review by Brooks et al. (2020b) several crucial quarantine potential psychological costs are shown: the separation from loved ones, the loss of freedom, uncertainty over disease status, boredom, suicide, substantial anger and irritability, confusion (poor concentration and indecisiveness), fear, grief, numbness, anxiety-induced insomnia, symptoms of depression and acute stress disorder, emotional and physical exhaustion, detachment from others, and guilt. During quarantine additional stressors were identified: longer duration of quarantine, distress and frustration caused by a sense of isolation and a loss of usual routine, fear of infection or of infecting others, inadequate basic supplies and information (in particular, lack of clarity about the different levels of health risk). Also post quarantine period has its own specific stressors, such as socioeconomic distress (following financial loss) and stigmatization and rejection from others after been quarantined. In conclusion, besides the Covid-19 pandemic distress-related, the additional psychological impact of quarantine exists, and it is wide-ranging, substantial, and can be long lasting.

### 1.2.2.1. *Covid-19 Pandemic: the Italian Context*

According to the Superior Health Institute (Istituto Superiore di Sanità – ISS, 2020), the 30 January 2020 the first two Covid-19 infection cases in Italy were confirmed, and then, the 21 February the first autochthonous case in Italy was registered. Then, a rapid spread of the contagions was reported in the first weeks of March. This situation led the Italian Government to dispose several measures (in line with those already adopted in China) to reduce the transmission of the virus, and since March 10 a lockdown was demanded to the Italian population. This measure, that lasted until 4 May, included avoiding gathering of people, maintaining social distance (e.g., at least 1m of distance), going out only if strictly necessary (e.g., for basic supplies, for work if physical presence was essential), blocking all the unnecessary economic activities (e.g., gyms, restaurants, and beauty centers) and closing schools of every order and grade (Favieri, Forte, Tambelli, & Casagrande, 2021).

A second wave started in autumn 2020, causing again restrictions, such as a national curfew and different levels of limitation depending on the rate of spread of the virus in each region (to which is assigned different colors representing the different degrees of risk, that in ascending order are: white, yellow, orange, and red). These restrictions have been loosened at the end of April 2021, for a reduction in the number of positive cases to Covid-19, accomplice also the vaccination campaign started at the end of 2020 (Governo Italiano, 2022). From 1 April 2022, the state of emergency in Italy, proclaimed for the first time on 31 January 2020, has ceased; and always from 1 April, is no longer used the classification of the Italian regions in different risk scenarios, commonly known as "white zone", "yellow", "orange" and "red" (Gazzetta Ufficiale, 2022).

So, in conclusion, starting from February 2020, cumulative data disposed in September 2022 from the ISS (2022), indicates 22.107.602 confirmed cases of Covid-19, including 172.218 deaths.

### 1.2.2.2. *Pregnancy and Parenting during Covid-19*

In this specific Covid-19 pandemic context being pregnant or being a parent of young children appears to be a risk factor in terms of psychological impact of the pandemic (Brooks et al., 2020b). Evidence highlights in fact how pregnant and postpartum women, and their infants, may be a particularly vulnerable population in case of natural or technical disasters, especially to the mental health consequences of disasters (Harville, Xiong, & Buekens, 2010).

In fact, thinking to this historical period, pregnant and postpartum women have had to face, besides all the changes and stressors that characterize these moments of transition in a woman's life, the Covid-19 pandemic, its quarantine related measures, the consequent social isolation (making impossible to have their family for practical and emotional support), disruptions in medical practices (for example the impossibility or uncertainty of having the partner during labor and in the first days after childbirth, or the stop of in-person visits, substituted by phone or video visits for prenatal care), and job and economic instability (Moyer, Compton, Kaselitz, & Muzik, 2020; Quatraro, 2021; Yan et al., 2020).

If a greater increase in prevalence of psychological morbidities (in terms of poor sleep quality, insomnia, stress, psychological distress, post-traumatic stress symptoms, anxiety, and depression) was registered in general population during this pandemic period compared to normal times (Krishnamoorthy, Nagarajan, Saya, & Menon, 2020; Liu, Zhang, Wong, Hyun, & Hahm, 2020), prevalence for women in perinatal period are even higher. In fact, anxiety, depression, psychological distress, and insomnia, in pregnant and postpartum women during the Covid-19 pandemic, was registered as higher compared to data before Covid-19 and compared to general population during Covid-19 (Hessami et al., 2020; Yan, Ding, & Guo, 2020). Authors above mentioned also highlighted some risk factors for maternal mental health during Covid-19 pandemic, as for example being a multigravida woman (which is connected with higher levels of depression and anxiety), maybe, because, in accord to the pre-existing literature (Dipietro, Costigan, & Sipsma, 2008; Figueiredo, & Conde, 2011), they have to face more challenges (like the fact of having an additional child, of having to reorganize the existing parental system, and to face the increase in parental and financial responsibilities).

In this reasoning, not only being a mom-to-be or a new-mom are conditions to pay attention to, but also parenting is affected by Covid-19 pandemic. This environmental condition has changed family life: on one side children were out of school or child care, with no possibility to access to group activities, team sports, or playground, and on the other side, contemporary, parents and caregivers have to concern about work (by going physically to work when necessary or by working remotely), the pandemic situation, its socio-economic consequences, and, all this, while caring for their children (Cluver et al., 2020). And, considering this stressful situation, even if it may include positive factors for parents (e.g., the ability to spend more time with their family and children), the perceived impact of Covid-19 among parents is associated with increased parental stress and increased risk of harsh parenting (Chung, Lanier, & Wong, 2020). In fact, as parental stress levels rise, parents may also be more likely to experiment parental burnout (Griffith, 2020), and, therefore, to engage in abusive parenting or neglect (Beckerman, van Berkel, Mesman, & Alink, 2017; Fontanesi et al., 2020), where symptoms of anxiety and depression, as well as poor sleep (registered in parents during Covid-19 by Brown, Doom, Lechuga-Peña, Watamura, & Koppels, 2020), represent an additional risk factor.

To sum up, the global pandemic Covid-19 is a stress factor that originated outside the family system, but, considering its features of uncertainty and novelty, it is likely to be perceived as a significant cumulative stress source for many parents and children (Brown et al., 2020). Indeed, just like natural disasters, the Covid-19 health emergency, with its concerns and fears, represents an opportunity to study longitudinally PNMS effects on offspring and what kind of help and intervention can be made to promote mental health, well-being and for reduce distress in pregnant women, new-mothers and their children.

## 1.3. PRENATAL MATERNAL STRESS (PNMS) AND MENTAL HEALTH

As previously discussed, prenatal maternal mental health recently found its place in the "Developmental Origins of Health and Disease – DOHaD" paradigm (O'Donnell & Meaney, 2017). Indeed, in this direction, the role of Prenatal Maternal Stress (PNMS) on offspring has been studied and consequently confirmed, in animal and human studies, in terms of higher risk for later psychopathology (Glover, 2011; Glover, O'Connor, O'Donnell, & Fisher, 2018; Van den Bergh et al., 2020). By taking an evolutionary perspective we can better understand these effects of prenatal distress exposure (i.e., anxiety, depression and acute and chronic stressors): like in the case of maternal malnutrition during pregnancy studied by Hales and Barker (1992), the fetus obtains its information about the future environment from its mother (by nutrients, hormones and chemicals variations), in order to better succeed, in this specific PNMS case, in a stressful environment, where a certain type of fetal programming could be adaptive (Glover, 2011).

From a neurobiological point of view, we can mention several changes that refers to the peripartum period, which may be negatively influenced by PNMS (Pearson et al., 2011) and characterized by individual differences, to which we can associate different outcomes, in terms of psychopathology risk and caregiving behavior (Cárdenas, Kujawa, & Humphreys, 2020). In particular, across gestation we can observe modified hormones levels (Douglas, 2010; Kumar & Magon, 2012; Nissen, Gustavsson, Widström, & Uvnäs-Moberg, 1998; Thompson & Trevathan, 2008), which can also shape neuroanatomical changes in mother's brain (Carmona et al., 2019); alterations in maternal immune system (Munoz-Suano, Hamilton, & Betz, 2011); structural brain changes, including reduction

in gray matter volume and subcortical brain regions (like in pituitary gland and hippocampus) (Hoekzema et al., 2017). These neurobiological modifications, also known as "maternal programming", which appears to be impaired when PNMS is present (Pearson, 2010; Pearson et al., 2011), are in fact assumed them as useful and adaptive with the aim to prepare women for the emotional and cognitive demands involved in caring for a child (Barba-Müller, Craddock, Carmona, & Hoekzema, 2018).

From a psychological point of view, we assist to an instability and fluctuation of emotion during the pregnancy period at different gestational times (Newham & Martin, 2013; Rofé, Littner, & Lewin, 1993), which is in fact also defined as an "emotional ambivalence" condition (Bjelica, Cetkovic, Trninic-Pjevic, & Mladenovic-Segedi, 2018). As Slade and Sadler (2018, p.25-40) affirm, pregnancy is "a time of major transition, reorganization, and integration for the mother-to-be, greatly affected by her biology, life experience, and psychology", and a time where several changes, both on biological/physiological level and on psychological and social functioning one, take place (Bjelica et al., 2018). Pregnant women have a complex task to perform, because they have to cope with the transition to the maternal role, which is, in the qualitative perspective of Darvill, Skirton, and Farrand (2010), composed by "changes in the woman's self-concept", which includes three main themes: control, support and forming a family. These themes refer to the feelings of vulnerability, lack of control, disorientation, high emotional turmoil, need of support and help (in their mothers, partners, relatives, friends…), union with the partner, responsibility for the child, strong bonding with the fetus (even before the infant was born). In other words, it's during pregnancy (or sometimes even before) which starts a process called by Mercer (2004) "Becoming A Mother" (BAM), which replace the previous terminology "Maternal Role Attainment" (MRA) (Rubin, 1967). BAM refers to a continuous process of adaptation with its major theme in reaching a "new normal", describing, in this way, the transition to motherhood as an intensive commitment and active involvement, which is made by different stages. These ones are: (a) in pregnancy: commitment, attachment, and preparation; (b) up to 6 weeks postpartum: acquaintance, learning, and physical restoration; (c) 2-4 months postpartum: moving toward a new normal; and (d) around 4 months: achievement of the maternal identity (Mercer, 2004). The stages identified are variable in length, depending on the infant (on his temperament, his responsiveness…), the mother (on the

representation of her own mother, the current relationship with her own mother, her memories of parental acceptance as a child…) and their social context, and they can also overlap each other (Mercer, 2004; 2006).

Also, in parallel with the representation of herself as a mother, from a more psychosocial point of view we can highlight the fact that women have also to renegotiate their role in society, trying to adjust to their new social status, as well as to their personal context and their social circle. This brings also a change in intergenerational roles and relationships, in particular with the partner, with whom faces the co-parenting and all its changes and challenges (Parolin & Sudati, 2014, pp. 23-48).

All of these changes involved in pregnancy are crucial for two main reasons: on one side all these adjustments are relevant for quality of interactions and of future relationship mother-child (Parolin & Sudati, 2014, p. 23-48), and on the other side these transformations can represent a stressful situation for the mother, which can trigger or potentiate psychopathology in the mother, that may in turn influence the child development and the relation with him (Slade, 2002; Slade & Sadler, 2018). Despite this evidence, in 2015 the World Health Organization (WHO), about the pregnancy period, highlights how maternal mental health is one of the most overlooked aspects of pregnancy care (O'Sullivan & Monk, 2020), which is coherent with the fact that traditionally, support in the postpartum period was the one to which health services have always focused (Henshaw, Elliott, & Cox, 2005). In fact, beside the variability (in terms of prevalence, severity level, trigger and intra-individual levels at different timepoints) (Furber, Garrod, Maloney, Lovell, & McGowan, 2009; Lee et al., 2007), non-psychotic mental health conditions are among the most common morbidities of pregnancy and the postpartum period (Howard et al., 2014).

*Depressive symptomatology* is one of the perinatal maternal psychopathology indices, which overall perinatal prevalence in women is about 12% (Woody, Ferrari, Siskind, Whiteford, & Harris, 2017). Depressive symptomatology causes significative distress or impairment from a psychological, social and occupational point of view of functioning, and it refers mostly to sad or low mood, diminished interest or pleasure for activities, diminished energy or fatigue, alteration in eating, sleep and in terms of agitation/slowing of movements, and focusing on the cognitive plan, in case of

depression, we can observe feeling of worthlessness or guilt, low self-confidence, reduced ability to concentrate or to make decisions, death thoughts and suicidal ideation (American Psychiatric Association 2013; World Health Organization, 1993). Concerning depression related to pregnancy and postpartum periods: perinatal depression is defined by the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5) as a major depressive episode (MDD) with peripartum onset (which means that symptoms develop during pregnancy or within four weeks following childbirth) (American Psychiatric Association, 2013). Early depression detection is crucial because, first of all, postnatally, these symptoms negatively impact woman's abilities to care for her new baby, as well as her abilities to maintain relationships with significant others (Stewart, 2011).

Within maternal perinatal psychopathology, alongside depression, evidence also suggests *anxiety disorders*, of which most recent data indicates a 15% prevalence of perinatal anxiety in women (Dennis, Falah-Hassani, & Shiri, 2017). Generally, anxiety disorders manifest themselves as excessive anxiety or worry, fatigue, irritability, restlessness, impaired concentration, sleeping difficulties, and increased muscle aches, soreness or tension (American Psychiatric Association 2013). Specifically concerning antenatal anxiety, Brockington et al. (2006) found some frequent fears, which refer to: fetal abnormality and/or death, inadequacy as a mother, tokophobia (fear of childbirth), and inadequate social support. As well as we have said above for depression, also anxiety disorders, if not treated, have consequences in the postpartum period, like negative effects on breast-feeding, and on bonding and on mother–infant interactions (Field, 2018).

Just like in the non-pregnant population, also taking into consideration the perinatal period, comorbidity between depression and anxiety is found (Wisner et al., 2013). Therefore, most of the risk factors detected are relevant to both conditions, and, in fact, shared risk factors are: lack of social support, lack or poor partner relationship quality, past or current abuse or domestic violence, personal history of mental illness, adverse and stressful life events, present/past pregnancy complications or pregnancy loss, low income and education level, current or past smoking, and, finally, negative cognitive style/low self-esteem and self-efficacy (Biaggi, Conroy, Pawlby, & Pariante, 2016; Lancaster et al., 2010; Lee et al., 2007). Other risk factors of which we have controversial data are mother's age (younger vs. older) and being nulliparous or multiparous; and others of which we have little evidence available are current/past alcohol or substance abuse,

family history of mental illness, parenting in terms of quality/style, mode of delivery and partner unemployed (Biaggi et al., 2016).

Another form of PNMS that we can consider here is the *Post-Traumatic Stress Disorder (PTSD)*, which most recent overall mean prevalence in the perinatal period, given in a meta-analytic work (Yildiz, Ayers, & Phillips, 2017), is 4.6% for prenatal PTSD and 5.44% for postnatal PTSD. PTSD expresses itself through the following symptoms, following a traumatic event: flashbacks, nightmares, physical reactivity, upsetting memories, unjustified and exaggerated sense of guilt, negative affect, decreased interest in activities, hypervigilance, difficulty in concentration and sleeping, irritability, and risky or destructive behavior (American Psychiatry Association, 2013). Most of PTSD research focuses on PTSD childbirth related, where the traumatic experience can be represented by delivery (Dikmen-Yildiz, Ayers, & Phillips, 2018). It's important to also consider PTSD in the perinatal period because of the negative effects associated with it, like higher risk of depression (Shahar, Herishanu-Gilutz, Holcberg, & Kofman, 2015), problems in the parent-infant relationship (Davies, Slade, Wright, & Stewart, 2008), and marital difficulties (Ayers, Eagle, & Waring, 2006), that may extend or impede recovery (Dikmen-Yildiz et al., 2018).

A little mention, considering maternal mental health, can be done for *eating disorders (EDs)*, that we can observe trough symptoms like self-induced vomiting (SIV), laxative use, exercise behavior, and appraisals and concerns about weight gain, dieting, and shape (Micali, Treasure, & Simonoff, 2007). In fact, even if EDs are relatively rare in perinatal period, in case of recent ED, the disorder can continue in pregnancy (but fewer than before pregnancy), and in case of past ED (which is a past condition concerning 15% of pregnant women), its symptoms can reappear in pregnancy, even if less intense (Howard, & Khalifeh, 2020; Micali et al., 2007). EDs are relevant not only for their importance in fetal programming (as highlighted originally by Barker 1994; 2004), but they represent also a risk factor for developing depression and anxiety perinatally (Micali, Simonoff, & Treasure, 2011).

### 1.3.1.    *Prenatal Maternal Stress as a Risk Factor*

Prenatal maternal stress exposure is an emerging risk factor for health outcomes, resulting from fetal programming (Davis & Sandman, 2010; Stein et al., 2014).

The *first altered mechanism* concerns the neural circuits for stress. Evidence in human and animal studies suggest that maternal stress hormones have been suggested as a pathway in which such fetal programming (Barker, 1994) effects could occur (Glover, O'Connor, & O'Donnell, 2010; Harris & Seckl, 2011). One of the main physiological systems susceptible to stress is the hypothalamic-pituitary-adrenal axis (HPA), whose main hormones involved are corticotropin- releasing hormone (CRH), adrenocorticotropic hormone (ACTH), and cortisol (the most important human hormone belonging to the glucocorticoids – GCs) (La Marca-Ghaemmaghami & Ehlert, 2015). This axis follows a circadian rhythm (Levine, Zagoory-Sharon, Feldman, Lewis, & Weller, 2007) and it is also activated by stress triggers. To prevent prolonged or excessive HPA activation, when cortisol levels become elevated, cortisol itself produces negative feedback, which inhibits the axis and the secretion of the involved hormones (Ulrich-Lai & Herman, 2009). Also, always about cortisol, its specific small molecular mass, and its lipophilic nature, allows it to cross the cell membranes of target tissues throughout the body, including the brain and, in pregnancy, also the placenta (Gunnar & Quevedo, 2007).

By keep taking into account the HPA axis, but referring specifically to pregnancy, it is known that "pregnancy can be characterized as a state of mild but sustained hypercortisolism" (McLean & Smith, 1999), because, due to the fact that the placenta begins to produce CRH and ACTH, activity of the HPA axis increases with progressing gestation (Lindsay & Nieman, 2005). Glucocorticoids (GCs) are crucial during fetal development (affecting maturation of tissues and organs, cellular differentiation…), so much so that these are used, in their synthetic form, as treatment in preterm pregnancies (Cottrell & Seckl, 2009). But nevertheless, the fetus has to protect itself from the maternal elevated stress hormones concentration, which is possible thanks to the placental enzyme, 11β-hydroxysteroid dehydrogenase type 2 (11β-HSD2) activity, which in fact represents a barrier that regulates the amount of maternal cortisol that crosses the placenta (by oxidating a part of cortisol to its inactive cortisone form) (Benediktsson, Calder, Edwards, & Seckl, 1997), that otherwise would be excessive, causing possible negative outcomes

for the fetus, like low-birth weight, hyperglycemia, hypertension, increased HPA axis reactivity, and increased anxiety-related behavior (Harris & Seckl, 2011). Which is crucial for PNMS is that, there is evidence, not only in animal studies (Harris and Seckl, 2011; Mairesse et al., 2007; Weaver et al., 2004; Weinstock, 2005; 2008; Welberg, Thrivikiranman, & Plotsky, 2005), but also in human ones (O'Donnell et al., 2012; Ponder et al., 2011), of a diminished activity of 11β-HSD2 enzyme face to maternal stress (and a consequent high levels of GCs and also long-lasting increase in the sensitivity of the HPA axis) (Van der Bergh et al., 2020). Another similar diminished effect of the enzyme 11β-HSD2 activity in humans has been attributed to the Glycyrrhizin, a natural constituent of licorice, when consumed in large amounts during pregnancy, allowing, in this way, to study the possible effects of PNMS (Räikkönen et al., 2010). Results from Nederhof & Schmidt (2012), O'Connor et al. (2005), and Räikkönen et al. (2010), point out that higher prenatal cortisol levels produce alteration in HPA axis functioning in eight-year-old offspring.

The *second mechanism* that we will consider is about epigenetic variation: in fact, we know that prenatal and postnatal experiences may induce alterations (in particular, in DNA methylation) in offspring outcomes. A link between PNMS and a modification in DNA methylation was found: a reduced CRH gene DNA methylation and an increased NR3C1 gene methylation, which are responsible for receptors in hypothalamic tissue for GCs. Following these findings, that can be observed beyond infancy (because demonstrations in 10-19 years after birth are available; Radtke et al., 2011), a dysregulation of HPA function has been implicated as a primary outcome (Monk, Spicer, & Champagne, 2012).

The *last PNMS biomechanism* that we will see is about maternal immune system, and it highlights how stressors also engage the immune system, and, in particular, by increasing the production and circulation of pro-inflammatory cytokines (which are a detectable proxy measure for current infections) in the body (Johnson, Riley, Granger, & Riis, 2013). Therefore, it was found an association between PNMS and higher proinflammatory cytokines levels (that can down-regulate 11β-HSD2 enzyme levels) (Harris & Seckl, 2011), which is also linked with offspring's mental disorders outcomes (Blackmore et al., 2011; O'Connor, Monk, & Fitelson, 2014).

To conclude, excessive maternal stress during pregnancy is a risk factor for adverse pregnancy outcomes and it may "program" fetal development, so that offspring are exposed to physical and mental health problems later in life (La Marca-Ghaemmaghami & Ehlert, 2015).

### 1.3.2. *Prenatal Maternal Stress: Outcomes on Offspring*

So far, we have presented PNMS in terms of: what might increase the likelihood of PNMS (all the changes that the woman has to face during pregnancy, and which can therefore cause her distress); the forms that PNMS may take (i.e., depression, anxiety, PTSD and eating disorders); and in this paragraph we will focus on analyzing what are the possible consequences of PNMS (thus specifying why it may be a risk factor and in what terms).

Evidence in this last field is available thanks to longitudinal projects, like the ones conducted with cohorts of women in the perinatal period concurrently with natural disasters (SPIRAL; Stress in Pregnancy International Research ALliance). Instead, some projects where the stressor wasn't as defined as in natural disasters studies, but that gave us anyways evidence about a strong link between PNMS and children outcomes, even in long term, are: the ALSPAC (the Avon Longitudinal Study of Parents and Children), which started in the United Kingdom in 1991, and that now includes original children of the '90s, their parents and children; the ABCD (the Amsterdam Born Children and their Development), that started in 2003 and follows almost 8000 children until adulthood; the Preschool ADHD, which recently selected participants from the Norwegian Mother, Father and Child Cohort Study (MoBa; Bendiksen et al., 2020); the Generation R study, which collects data from fetal life to adulthood, and which has, lately, launched a new cohort study called "Generation R Next"; the RHEA study, another mother-child cohort which follows the offspring until their six years of age.

First of all, PNMS has been associated with adverse perinatal and obstetrical outcomes, meaning, more specifically: earlier birth (in terms of increased odds and spontaneous preterm birth), low birthweight (in terms of increased odds and effective lower mean birthweight), small for gestational age (SGA) and smaller head circumference

at birth (Ding et al., 2014; González-Mesa, Arroyo-González, Ibrahim-Díez, & Cazorla-Granados, 2019; Grigoriadis et al., 2018; Lobel et al., 2008).

Other offspring development domains are affected by PNMS, like *cognitive function* in children exposed to stress conditions in early stages of intra-uterine life. We can refer to several evidence that shows a reduction in cognitive performance (also including language and general cognitive development) in association with PNMS (Glover, 2014; Laplante, Brunet, Schmitz, Ciampi, & King, 2008; Mennes, Stiers, Lagae, & Van den Bergh, 2006). This cognitive impairment can be even worse if we consider the possibility of a negative cumulative effect, by showing results that highlights how unfavorable birth outcomes, and, in particular preterm birth and low birthweight, have moderate-to-severe deficits in cognitive domain and academic achievement (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Shenkin, Starr, & Deary, 2004).

By keeping resuming child outcomes face to PNMS we can now consider *emotional and behavioral difficulties*, which are usually conceptualized as being either internalizing or externalizing (Stein et al., 2014). Starting with the *internalizing* ones (that include depressive of anxiety symptoms or proper diagnosis), we can report that antenatal depression, in longitudinal studies, is associated with a greater risk of internalizing and emotional problems in children (Gerardin et al., 2011; Leis, Heron, Stuart, & Mendelson, 2014; Velders et al., 2011), which may persist until adolescence (O'Donnell, Glover, Barker, & O'Connor, 2014). This adverse symptomatology in childhood that can lead also, in late adolescence, to a higher risk of clinical depression (Pawlby, Hay, Sharp, Waters, & O'Keane, 2009; Pearson et al., 2012), and, in preadolescence, to an increased risk for anxiety (Davis & Sandman, 2012).

On the other hand, with *externalizing difficulties* we refer to attention deficit hyperactivity disorder (ADHD), oppositional defiant disorder, conduct disorder, or similar symptoms. Results available in literature show an existing link between prenatal maternal mental health (considering antenatal depression and anxiety) and externalizing behavior issues in offspring (Barker, Jaffee, Uher, & Maughan, 2011; Eddes et al., 2012; Velders et al., 2011). Evidence goes also beyond childhood, investigating the well-being of adolescents exposed to PNMS (Korhonen, Luoma, Salmelin, & Tamminen, 2012), age

group in which, in only one study conducted by Hay, Pawlby, Waters, Perra, and Sharp (2010), PNMS seemed to predict violent and antisocial outcomes. The evidence, just presented, about difficulties in externalization behaviors can become stronger given the offspring outcomes arising from the altered biomechanisms in pregnancy in response to PNMS (in particular, altered HPA reactivity) (Nederhof & Schmidt, 2012; O'Connor et al., 2005; Räikkönen et al., 2010). In fact, reacting to a stressful intra-uterine environment the child may adapt himself by increasing the characteristics that could be adaptive in such postnatal environment, thus showing increased vigilance, distractible attention with more perception of danger, impulsivity with more exploration, conduct disorder with the intention to break rules, and aggression (Glover, 2011).

Also *motor development* may be negatively affected by PNMS; for example, in the context of natural disasters, Simcock, Laplante, Elgebeili, Kildea, & King (2018) report, related to higher levels of PNMS, poorer gross and fine motor development, both in early infancy, and later (evidence that confirmed existing evidence at 5 ½ years old; Cao, Laplante, Brunet, Ciampi, & King, 2014). These results confirmed previous data about impaired motor development face to PNMS (Glover, 2014; Grace, Bulsara, Robinson, & Hands, 2016).

Concerning *physical growth*, PNMS seems to shape different offspring outcomes: first of all, it is associated with fetal growth restriction (Lewis, Austin, & Galbally, 2016), but considering later child development we have several evidence in favor of the idea that PNMS predicts higher body mass index levels and central adiposity in children and adolescents (effect that tend also to increase as the children grow older; Liu, Dancause, Elgbeili, Laplante, & King, 2016), which seems to have a crucial role in the relationship between PNMS and age at menarche (AAM) (Duchesne, Liu, Jones, Laplante, & King, 2017). Also results about altered postnatal immune system in offspring, that may expose in turn to a higher risk for asthma, have been found (Cao-Lei et al., 2016; Turcotte-Tremblay et al., 2014).

If we consider *neurobiological outcomes* in offspring exposed to PNMS, besides the HPA axis dysregulation mentioned above (Nederhof & Schmidt, 2012; O'Connor et al., 2005; Räikkönen et al., 2010), Buss et al. (2010) found that, focusing particularly on brain morphology, PNMS (when it was registered as high at 19 gestational weeks, but not

if we consider PNMS at 25 and 31 gestational weeks) predicted reduced gray matter volume in areas involved with cognitive performance (in particular learning and memory), and more specifically: in the prefrontal cortex, the premotor cortex, the medial temporal lobe, the lateral temporal cortex, the postcentral gyrus as well as the cerebellum extending to the middle occipital gyrus and the fusiform gyrus. The authors above-mentioned, for the first time, show in this way how PNMS influence brain development in terms of morphology by taking into consideration specific temporal development patterns (Monk et al., 2012).

Facing the risk of *mental disorders* and *psychopathology* in offspring after PNMS we can mention, in addition to what it was said earlier in the same sub-paragraph, even if we only dispose of controversial and little data, we can mention an increased risk for autism spectrum disorder (ASD) (Kinney et al., 2008; Laplante et al., 2019; Manzari, Matvienko-Sikar, Baldoni, O'Keeffe, & Khashan, 2019; Simcock et al., 2017a; Walder et al., 2014) and schizophrenia (Khashan et al., 2008).

So, to conclude, in order to avoid or to reduce the impact of adverse maternal neonatal, infant and child outcomes associated to PNMS, it appears clear the relevance of interventions to promote maternal mental health in pregnancy. Starting with early screening initiative, it's possible to detect any maternal psychological difficulty and to intervene. Basing the reasoning on strong evidence, considering psychological and psychosocial interventions, not excluding the need for interventions tailored for pregnancy and for the development of the mother-child relationship, there is no reason to suppose that treatments that are effective in other moments of a woman's life would be ineffective during the perinatal period. Thus, considering the large evidence on various types of interventions to promote mental health, it seems even more necessary and accessible to think of an effort to reduce maternal suffering in the perinatal period and to produce positive impact (even a long-term impact) on families (Howard, & Khalifeh, 2020).

## *1.4. MATERNAL PTSD IN PERINATAL PERIOD*

As previously seen, adverse maternal mental health conditions in the perinatal period are widespread (Howard et al., 2014). And, while depression and anxiety are the

most commonly recognized mental health disorders during the perinatal period, perinatal PTSD is less investigated (Moran Vozar, Van Arsdale, Gross, Hoff, & Pinch, 2021; Onoye et al., 2013), and that's exactly on this last-named disorder that we will reflect on in this work.

Usually maternal PTSD is both underrecognized, in terms of trauma effects on pregnancy and postpartum period (Geller & Stasko, 2017), and underestimate, because most studies examine the total prevalence of PTSD in the postnatal period related to traumatic childbirth experiences (Howard et al., 2014; Seng et al., 2010). In fact, only recently, PTSD has begun to emerge as a relevant mental health concern during pregnancy and postpartum (Seng et al. 2010), moreover because it has been lately theorized, basing on the prevalence of traumatic stress reactions during this time period, that a certain amount of psychiatric morbidity may in fact be the result of unrecognized and undiagnosed PTSD (Grekin & O'Hara, 2014).

This highlights that it is important to detect and treat PTSD among women in this period, since untreated perinatal traumatic stress and its effects have been associated with poorer biopsychosocial outcomes among mothers, but also among infants (Stevens et al., 2021), considering that pregnancy and postpartum overlap with sensitive periods of child brain development (Erickson et al., 2022).

### 1.4.1. *Maternal PTSD Perinatal Trajectories across transition to Parenthood*

Before starting with the PTSD overview in the specific period of pregnancy and postpartum, a little mention about how the estimated risk of occurrence of lifetime PTSD in women is twice as high as men, it's necessary. This sex difference in the prevalence of PTSD finds explanation both in the fact that women have increased exposure to traumatic events, and in the role of ovarian endogenous steroid hormones fluctuation (more specifically considering estradiol, progesterone, and its metabolite allopregnanolone) in female risk for PTSD (Ravi, Stevens, & Michopoulos, 2019). This second explication is also particularly relevant when we consider pregnancy period, when profound increase in ovarian steroid hormones is registered.

So, as we have said, this disorder characterizes the perinatal period, and by consequence has its own specific features. PTSD in the perinatal period can be triggered

by traumatic experiences during pregnancy or childbirth, or by traumatic events before conception (Ayers, 2004). As for DSM-5 (American Psychiatry Association, 2013) the definition of PTSD requires a traumatic event which involves actual or threatened death or serious injury of oneself or others. And thinking, for example, to childbirth it is possible to fill these criteria through perceived threat of injury or death to the infant or the woman or a threat to the physical integrity of the woman (Ayers, 2004).

When speaking about perinatal PTSD, as Geller and Stasko (2017) mention, it is also important to make a distinction between distress that arises from a pre-conception trauma and incident trauma related to the pregnancy or the childbirth, because they could have different developmental courses and implications for care.

In the first case, PTSD symptoms that there were present before pregnancy, and that may be undiagnosed or untreated (Onoye et al., 2013), can follow two different scenarios: they can continue into the perinatal period or otherwise they can resolve until pregnancy or childbirth-related events triggered relapse. In fact, some psychological aspects of pregnancy could increase vulnerability to develop PTSD, including childhood sexual trauma or intrafamilial abuse, previous pregnancy loss, or prior traumatic birth or when pregnancy is a result of sexual assault (for example physical aspects of pregnancy, like increased breast sensitivity, fetal movements, and pregnancy and prenatal care procedures are potentially triggering for PTSD) (Banyard, Williams, & Siegel, 2001; Seng, Low, Sperlich, Ronis, & Liberzon, 2009; Seng et al., 2010; Sperlich, & Seng, 2008). This vulnerability, however, does not only concern the condition of pregnancy and postpartum how highlighted by Seng et al. (2010), but it is instead crucial having had or not a perinatal complication. In fact, Sommer, Shamblaw, Mota, Reynolds, and El-Gabalawy (2021), by considering perinatal complications, arrive to clarify this point, facing the conflicting data that indicated on one side greater vulnerability in perinatal samples (PTSD rates of 4-5% higher in pregnant compared to nonpregnant women) (Seng et al., 2010) and on the other side the fact that pregnancy per se is not linked with increased risk of maternal mental disorders (except for the risk of major depressive disorder during postpartum) (Vesga-López et al., 2008). Instead, in the second case above mentioned (i.e., when trauma is related to the pregnancy or the childbirth) PTSD could also been accompanied by feelings of loss of control, and sometimes urgent medical intervention, severe pain, and humiliation (Beck, Driscoll, & Watson, 2013).

Considering the pregnancy period and the first postpartum year we can also highlight longitudinal changes in PTSD throughout the perinatal period from early pregnancy through postpartum. In a study conducted by Onoye et al. (2013) it is shown that during pregnancy there was a general declining trend in PTSD symptom scores, except for a "spike" in PTSD rates in late third trimester (weeks just prior to delivery), that tended to decline in the postpartum period. The women's recover during the initial months after giving birth is confirmed also in another cohort studied by Haagen, Moerbeek, Olde, van der Hart, and Kleber (2015). But this last finding is in contrast with other evidence (Alcorn, O'Donovan, Patrick, Creedy, & Devilly, 2010; Zaers, Waschke, & Ehlert, 2008), which identified the presence of chronic PTSD: persistence or aggravation of PTSD symptoms over time, highlighting, in this way, how PTSD longitudinal trajectory is a heterogeneous phenomenon, and how women's reactions and response vary greatly (Dikmen-Yildiz et al., 2018).

Continuing to explore PTSD trajectory over time, we can mention a recent systematic review and meta-analysis (Yildiz et al., 2017), that tried to overcome some precedent reviews limits, and to give a better understanding of the epidemiology of perinatal PTSD (during prepartum and postpartum period), by considering both studies that used self-report instrument and studies with clinical interview assessment to evaluate PTSD symptoms, and both studies which evaluate PTSD symptoms in high risk pregnancies (HRPs) and non-high risk pregnancies (i.e., community samples). This heterogeneity in the methodological design of the selected studies allow the authors to affirm that PTSD prevalence in HRPs was higher (both in pregnancy and in the postpartum) compared to community samples; that there was no significative difference in PTSD symptoms even if different measures were used; and, as last thing, that, in both type of samples, PTSD prevalence rises at 6 months postpartum. This last result could complete the longitudinal analyses changes in postpartum PTSD prevalence reported before, seen that Onoye et al. (2013) reported the moment of the unique PTSD symptoms assessment postpartum in an approximate way (i.e., before and after 6 weeks postpartum), not allowing us to understand if this assessment could have happened at 6 months postpartum, like the studied considered by Yildiz et al. (2017). Anyways, to conclude with the prevalence PTSD rate, it is important to highlight the great existing variability in literature, with a systematic review which report a prevalence percentage from 0% to

21% in community samples, and from 0% to 43% in high-risk samples (Khoramroudi, 2018), but still confirming also here that the prevalence of PTSD seems to increase from 1 to 6 months after delivery.

Another gap that we can highlight in PTSD research is the fact that few studies investigate maternal PTSD from pregnancy to postpartum period focusing on resilience, adaptation, recovery, post-traumatic growth, and positive changes, while most of studies are centered on trauma psychopathology (Dikmen-Yildiz et al., 2018). In fact, these authors assume, referring to PTSD following traumatic birth, that women's response patterns can be conceived as common trajectories of PTSD in other trauma population, detecting four distinct trajectory groups with different longitudinal patterns. The groups that can be identified are: resilient (stable absence of symptoms throughout the follow up period), recovered (initial PTSD symptoms with a decreasing pattern over time), chronic (elevated PTSD symptoms maintained over time), and delayed-PTSD (worsening of symptoms over time) (Bonanno, 2004; Norris, Tracy, & Galea, 2009). To our knowledge only two studies until now, considering women belonging to community samples but with a traumatic childbirth, have applied an interpretation of the prevalence of perinatal PTSD through different patterns of longitudinal trajectories. They show once again how the trend of symptoms varies greatly, and register a resilient group that represented the majority of the sample in both cases, and a chronic one represented by 13.7% of Dikmen-Yildiz et al. sample (2018) and by 6.5% of Malaju, Alene, and Bisetegn (2022) sample. This distribution in the four trajectory groups is also available for HRPs, in one study conducted including mothers of neonatal intensive care unit (NICU) discharged infants', where the resilient group is still the majority and the chronic one is represented by the 9.2% of the sample (Kim et al., 2015). These studies represent an occasion to study both positive and negative outcomes after a traumatic birth or an HRP, providing also a more comprehensive understanding, in order to detect women at low and high risk for PTSD, and accordingly, take appropriate action (Dikmen-Yildiz et al., 2018).

It is therefore crucial to highlight recommendations for perinatal PTSD, also seen that it is not commonly included in the conversation concerning mental health concerns for perinatal or postpartum women (Moran Vozar et al., 2021). So, delivering psychoeducation interventions for pregnant, and trauma-exposed women with PTSD symptoms it is important, and even more important if there is existing evidence that

indicates how these interventions are acceptable and feasible by women, and also effective in terms of improved perinatal outcomes (Stevens et al., 2021).

### 1.4.2. *Covid-19 Context and Other Risk Factors for Maternal PTSD*

If we consider that PTSD, like others maternal mental health indicator, is registered in women belonging to community samples, we know also that its prevalence in pregnant and postpartum women is higher in adverse conditions (Yildiz et al., 2017). These conditions may concern different prepartum, intrapartum and postpartum factors which may influence PTSD prevalence and trajectory over time, considering the pregnancy and the first postpartum year (Molgora & Accordini, 2020).

We can split these factors based on the fact that some of these (to which we can refer as "Predisposing Risk Factors for Maternal PTSD") refer to specific characteristics of the mother or the pregnancy, which may not change over time, nor be affected by other surrounding conditions, as descriptive of the general circumstances in which we can observe the PTSD trajectory; instead, other possible risk factors (to which we can refer as "Dynamic Risk Factors for Maternal PTSD") are elements that can change over time, both for a proper trajectory and/or for the influence of other co-existing factors.

The *predisposing risk factors* can be identified in different life events, such as history of mental health problems (including also psychiatric or psychological treatment); history of trauma or stressful life-event; interpersonal relational problems; intimate partner physical, psychological and sexual violence; medical problems or hospitalization during pregnancy; previous miscarriages or "traumatic" birth; psychosomatic vulnerability; previous counseling related to pregnancy/childbirth; being a primiparous or multiparous woman (even if there contrasting evidence about this: some claims that the multiparous condition is at higher risk for distress, while others affirm that it is the nulliparous condition which comes with more distress); labor expectations; a non-respected birth plan situation; delivery characteristics (such as subjective distress, duration, pain, feeling of no control during labor, interactions with medical staff perceived as negative, inadequate obstetric verbal treatment…); unplanned pregnancy; other obstetric complications or emergencies (particularly preterm birth, severe mobility and infant complications); and postpartum surgery or readmission to the hospital postpartum

(Andersen, Melvaer, Videbech, Lamont, & Joergensen, 2012; Ayers, Bond, Bertullies, & Wijma, 2016; Dekel, Stuebe, & Dishy, 2017; Dikmen-Yildiz et al., 2018; Grekin & O'Hara, 2014; Maggioni, Margola, & Filippi, 2006; Malaju et al., 2022; Malaju et al., 2022; Martínez-Vazquez, Rodríguez-Almagro, Hernández-Martínez, Delgado-Rodríguez, & Martínez-Galiano, 2021; Molgora & Accordini, 2020; Polacheck, Harari, Baum, & Strou, 2012; Ross & McLean, 2006; Schoch-Ruppen, Ehlert, Uggowitzer, Weymerskirch, & La Marca-Ghaemmaghami, 2018; Staneva, Morawska, Bogossian, & Wittkowski, 2016; Söderquist, Wijma, & Wijma, 2006). Other predisposing risk factors for developing PTSD during pregnancy have been found in demographic characteristics by Seng et al. (2009), like younger age, poverty, poor education, but little evidence confirm that these factors are associated with postpartum PTSD symptoms (Ayers & Ford, 2016). Also, in following evidence, investigating urban and racially diverse pregnancy sample, Black women living in the United States have higher rates to develop lifetime and perinatal PTSD (Seng, Low, Sperlich, Ronis, & Liberzon, 2011a; Seng, Kohn-Wood, McPherson, & Sperlich, 2011b).

*Dynamic risk factors* for maternal PTSD can be detected in low perceived social support (including single relationship status when high-risk pregnancies were considered) both in pregnancy and postpartum period, maternal mental health over time (in terms of anxiety and depression levels), and mental quality of life (i.e., daily functional impairment) (Andersen et al., 2012; Ayers et al., 2016; Dekel et al., 2017; Dikmen-Yildiz et al., 2018; Grekin & O'Hara, 2014; Malaju et al., 2022; Polacheck et al., 2012; Söderquist et al., 2006). In addition, key processes involved in the cognitive model have also been connected with postnatal PTSD, and in particular cognitive and behavioral predictors (i.e., nature of trauma memory, peritraumatic processing, negative appraisals of trauma and/or its sequelae, and poor or dysfunctional cognitive and behavioral strategies) have been investigated more recently (Ayers et al., 2016; King, McKenzie-McHarge, & Horsch, 2017).

Even though we have already made clear the fact that PTSD is not only the result of a single cause (i.e., a traumatic stressor), but is the consequence of various interacting risk factors (Haagen et al., 2015), we can conclude this paragraph by investigating traumatic stressor's characteristics which may play their role in the development of PTSD. As faced by Robert Bolin in "Disasters and Mental Health: Selected

Contemporary Perspectives" (1985, pp. 3-28), there are some disaster-related impact characteristics associated with mental health problems such as duration of impact, unexpectedness, pre- and post- impact threat, potential for prolonged alteration of the post-disaster environment and cultural and symbolic aspects. Thus, in literature are investigated different specific types of traumatic stress in relation to their effect on pregnant and postpartum women, like birth trauma and childhood maltreatment, and, recently, Covid-19 Pandemic (Erickson et al., 2022). Covid-19 impact should not be seen in terms of chronic (i.e., average) or episode effects, but it has to be conceptualized as a holistic pattern of continuing experience (Fu, Greco, Lennard, & Dimotakis, 2021), in which pregnant women experienced pandemic-related 'Preparedness Stress' (stress associated with feeling unprepared for birth because of Covid-19 pandemic) and 'Perinatal Infection Stress' (stress related to fears of perinatal Covid-19 infection) (Preis, Mahaffey, Heiselman, & Lobel, 2020a; Preis, Mahaffey, & Lobel, 2020c). Besides the risk factors already mentioned, Covid-19 adds some specific risk factors, such as experience of pandemic-related income loss, of believing of being infected with Covid-19, and of alterations in prenatal care; while having access to the outdoors and practicing healthy behaviors were identified as protective factors (Preis, Mahaffey, Heiselman, & Lobel, 2020b).

## 1.5. MATERNAL PERINATAL PTSD: ASSOCIATION WITH PARENTING AND CHILD DEVELOPMENT

After having analyzed evidence about the PTSD trajectories in the first-year postpartum, we can turn our gaze around what, in a certain sense, frame the mother's PTSD, considering both the whole dimension of parenting for a mother with a certain type of symptomatology, and some important domains of the development of the child in his first year of life.

Starting with the parenting domain, in the context of PTSD-related parenting deficits several consequences have been highlighted, like on parent–child interaction, as well as on child development. These relational patterns show significant similarities to the patterns between depressed or anxious parents and their children (Van Ee et al., 2016). About the impaired child-parent relationship several evidence comings from different

sources, highlights that, parents with PTSD symptoms, compared to those without symptoms of PTSD, in the long term perceived their relationship with the child as poorer (Ayers, Eagle, & Waring, 2006; Davies et al., 2008; Gewirtz, Polusny, DeGarmo, Khaylis, & Erbes, 2010; Jordan et al., 1992; Muzik et al., 2013; Nicholls & Ayers, 2007; Samper, Casey, King, & King, 2004), perceived their child as more difficult in temperament, and experienced more parenting stress (McDonald, Slade, Spiby, & Iles, 2011; Samuelson, Wilsn, Padrón, Lee, & Gavron, 2017). Problematic parenting in terms of higher risk for physical or sexual abuse of parents on children when PTSD symptoms were present is a controversial association: endorsement of moderate or severe aggression toward their children is registered in different studies (Cohen, Hien, & Batchelder, 2008; Hinton, Rasmussen, Nou, Pollack, & Good, 2009; Stover, Hall, McMahon, & Easton, 2012), but also a tendence of withdraw from the interaction with their children (making it less likely that they will be physically abusive) is reported (Greene, Haisley, Wallace, & Ford, 2020; Pears & Capaldi, 2001). Considering the sensitiveness of parenting, observational measurements showed that PTSD in mothers correlated with a parenting style which is less sensitive and responsive, more avoidant, overprotective, intrusive, hostile and controlling towards the child (Ayers et al., 2006; Feeley et al., 2011; Schechter et al., 2005; 2008). These mothers tend also to have a more insecure (''distorted'') mental representations of their child (Davies et al., 2008; Forcada-Guex, Borghini, Pierrehumbert, Ansermet, & Muller-Nix, 2011; Van Ee, Kleber, & Mooren, 2012).

This evidence highlights how the PTSD treatment for parents is important, considering that these parents are not only at risk for the several negative outcomes that we have just seen, but a higher risk of parental burnout is also demonstrated in literature. In fact, an exposure to chronic parenting stress can result in parental burnout, which is a specific syndrome composed by three principal dimensions: exhaustion related to the parental role, emotional distance from the child and sense of ineffectiveness in their role (Mikolajczak et al., 2018; Roskam et al., 2017).

We can now try to detect a theoretical framework able to explain the mechanisms involved in the impact of parental traumatization on their parenting, and consequently on their children (Van Ee et al., 2016): for example, Schechter et al. (2005; 2008) found that, applying to the mentalization construct (Fonagy, Target, Steele, & Steele, 1998), maternal PTSD symptomatology influence their formation of equilibrated, well-adjusted and

integrated mental representations of their children, which is relevant in this reasoning, because negative and distorted mental representations predict problematic behaviors (such as hostile-intrusive, negative and frightened-frightened). Other authors take into account the theory of attachment, where a responsive and sensitive parenting is crucial to develop a secure attachment (Bowlby, 1973), and highlight negative effects of parental PTSD on the attachment relationship, predicting an insecure attachment in children, and especially disorganized, because the children are attached to a parent that sometimes act in a fear-provoking way, creating a paradoxical situation (Green & Goldwyn, 2002; Hesse & Main, 1999). Always remaining within the framework of the theory of attachment, there are alternative data which shows no association between maternal symptoms of PTSD and infant attachment, and more specifically disorganized attachment (Lyons-Ruth & Block, 1996; Turton, Hughes, Fonagy, & Fainman, 2004). Otherwise, another explanation that was proposed refers to the bonding process of the mother to the child. In fact, women with PTSD symptomatology have also a poorer perception of the bonding to their infant (except when bonding is measured shortly after birth), as well as less desire of proximity to their infant (Ayers et al., 2006; Davies et al., 2008; Muzik et al., 2013; Nicholls & Ayers, 2007). Evidence that finds confirmation in two studies that investigated bonding perception of adolescents of parents with PTSD, which was less optimal compared to adolescents of parents without psychopathology (Boričević Maršanić, Aukst Margetić, Jukić, Matko, & Grgić, 2014; Field, Muong, & Sochanvimean, 2013).

But, in this attempt to identify the mechanisms underlying the association between parent PTSD and parenting stress, the inclusion of child factors is necessary (Van Ee et al., 2016), because parenting is also influenced by children's temperament (i.e., to children's physiological and neural responses to emotional stimuli) (Bates, Schermerhorn, & Petersen, 2012; McDonald et al., 2011; Muzik et al., 2017; Putnam, Sanson, & Rothbart, 2002; Samuelson et al., 2017), although the link between these variables is not unidirectional, and therefore more complex (Karreman, de Haas, van Tuijl, van Aken, & Deković, 2010). In fact, for completeness in the reasoning, we can now explore maternal perinatal PTSD associated with outcome of the child's development, considering mainly his temperament.

With child's temperament we are referring to early appearing dispositions which are present and detectable since birth, and which are both determined by innate

physiological mechanisms, and at the same time modified by environmental influences. Unlike the personality, with which it is often confused (even if it goes beyond temperament concept, including also a stable and coherent pattern of thought and behavior, that also has to do with the maturation of the individual), temperament refers to a tendency or a disposition of the individual with which he interacts with the environment, and also to a sort of nucleus from which develop the personality and individual differences that characterize the newborn (Fu & Pérez-Edgar, 2015; Rothbart, Ellis & Posner, 2004; Rothbart & Bates, 2006). The reason why it's important to consider temperament is that it can influence, among other domains, child development, especially in terms of behavioral problems and psychopathology (Caspi, Henry, McGee, Moffitt, & Silva, 1995; Martins, Cassiano, & Linhares, 2021; Nigg, 2006). In particular, Negative Affect trait is associated both with internalizing and externalizing behavioral problems, and Surgency and Effortful Control traits correlate negatively with internalizing behavioral problems, and positively with the externalizing ones (Berdan, Keane, & Calkins, 2008; De Pauw, Mervielde, & Van Leeuwen, 2009; De Pauw, Mervielde, Van Leeuwen, & De Clercq, 2011; Eisenberg et al., 2009; Gartstein, Putnam, & Rothbart, 2012; Kochanska, Barry, Jimenez, Hollatz, & Woodard, 2009).

If it has been confirmed that PNMS can affect offspring's temperament (Buthmann et al., 2019; Korja, Nolvi, Grant, & McMahon, 2017; Laplante, Brunet, & King, 2015; Nomura et al., 2019; Simcock et al., 2017b; Tees et al., 2010; Zhang et al., 2018), when we consider in particular PTSD symptomatology, the literature shows contradictory results (Cook, Ayers, & Horsch, 2018). In effect, there are in general few evidence on this specific relationship, where anyways some studies point out an existing link between postpartum PTSD, and more difficult infant temperament (Bosquet Enlow et al., 2011; Ionio & Di Blasio, 2014; Samuelson et al., 2017; Tees et al., 2010), while others (Muller-Nix et al., 2004) found no similar association. In addition, considering the link between child's temperament and behavior, maternal PTSD symptoms have been related to negative child outcomes, like internalizing and externalizing behavior, and emotionally reactive and aggressive behavior (Bosquet Enlow et al., 2011; Chemtob et al., 2010; Laor, Wollmer, & Cohen, 2001; Lieberman, Van Horn, & Ozer, 2005; Nomura & Chemtob, 2009; Parsons, Kehle, & Owen, 1990; Rosenheck & Fontana, 1998; Samuelson & Cashman, 2008).

However, no study, among those abovementioned for child development results associated to maternal PTSD, measured it antenatally, even if a possible explanation of the relationship between these maternal symptoms and offspring's temperament and behavior is given referring to the prenatal period. In fact, maternal PTSD may have a profound effect on children's self-regulatory abilities (Bosquet Enlow et al., 2011): fetal exposure to PNMS may have long-lasting consequences for children's self-regulation, where the underlying mechanisms recall as an explanation the possible role of the maternal HPA axis and changes in the placenta, including activity of 11β-HSD2 enzyme (O'Donnell, O'Connor, & Glover, 2009). But the prenatal exposure to PTSD symptomatology cannot explain by itself the association, highlighting that, like in other age-groups (i.e., childhood and adolescence), also in infancy, parental mental health (even considering fathers) impacts the offspring in terms of negative affectivity (Spry et al., 2020). And the way through which maternal postnatal PTSD can influence emotional regulation can be seen as direct, where maternal PTSD symptoms are observed, learned, and internalized by children who thus manifest behavioral and emotional difficulties (Samuelson et al., 2017). Otherwise, an alternative indirect explanation has been proposed: the relation between PTSD and emotional and behavioral regulation is assumed to be mediated by parenting stress (Morris, Criss, Silk, & Houltberg, 2017; Samuelson et al., 2017), considering firstly that a child's ability to emotionally regulate is learned through primary interactions (Morris et al., 2017); secondly that, exploring biological basis that can explain the impact of PTSD on parenting and children, we know that first-years-parenting quality has a role in shaping offspring's HPA activity, with a higher risk to develop extreme stress responses in case of lack of caregivers' regulation (Van Ee et al., 2016); and finally that parenting stress is related to adult psychopathology (Deater-Deckard, 1998).

In conclusion, pregnancy condition represents a complex moment for a woman's life (Bjelica et al., 2018), which is why stress exposure during this delicate period (PNMS) is not a rare situation, of which we can underestimate its impact. In fact, PNMS can manifest itself in different ways (i.e., depression, anxiety, post-traumatic stress disorder), and it can lead, through epigenetic mechanisms (Glover et al., 2018; Lequertier, 2018), to various adverse outcomes in terms of maternal mental health, mother-infant relationship, and child development (Slade, 2002; Slade & Sadler, 2018). In this frame

we have reflected in particular on evidence's regarding PTSD from pregnancy across transition to parenthood, and its mainly implications on two mutually dependent domains, meaning the parenting one and the child's emotional and behavioral regulation abilities (Bosquet Enlow et al., 2011; Korja et al., 2017; Van Ee et al., 2016).

# CHAPTER 2: RESEARCH PAPER

### *The heterogeneity of perinatal PTSD evolution in the time of the pandemic: an analysis of its predictors and of parenting and child development outcomes*

Pregnancy is a very particular and complex period in a woman's life, which presupposes a series of very important tasks from the psycho-social point of view. In particular, the psychological well-being of women engaged in the very first phases of maternity is crucial, since this period is challenged by a registered higher risk of mental illness, which can be explained by the exacerbation of new mental health problems, or also by the reoccurrence of pre-existing ones (Young & Ayers, 2021). Bearing this in mind, it is evident how perinatal mental health represents a major global concern, where early prevention (through universal and targeted screening programs) and consequent treatment, seem to be the best solution to avoid its deleterious consequences and to reduce the related public health costs (Kalra, Reilly, & Austin, 2018; Leigh & Milgrom, 2007; Waqas et al., 2022). Speaking of consequences, we can mention the maternal mental health potential implications on the woman herself (i.e., on her mental and physical health) and on the offspring (i.e., on their neurodevelopment, behavior, and risk for brain abnormalities and psychopathology) (Davis & Sandman, 2010; Erickson et al., 2022; Stein et al., 2014; Young & Ayers, 2021). In particular, studies on PNMS show a strong association between maternal stress exposure during pregnancy, and compromised future child development outcomes, that occur through underlying epigenetic mechanisms which may explain this intergenerational transmission of risk (Glover et al., 2018; Lequertier, 2018). Plus, the mother's emotional state during pregnancy could impact also maternal programming process (meaning the maternal neurocognitive changes, which occurs during pregnancy, to prepare her to respond towards her infant after birth; Pearson, 2010; Pearson, Lightman, & Evans, 2009; Pearson et al., 2012) and maternal postnatal mood (Heron, O'Connor, Evans, Golding, & Glover, 2004), which are two crucial elements considering parenting, that can be affected in its turn.

The vulnerability of prenatal maternal mental health is even more challenged when we consider environmental conditions that can bring additional stress (Lequertier, 2018). Therefore, considering the Covid-19 pandemic, we can say that it "is an important

source for the increased anxiety and stress among healthy pregnant mothers" (Mehdizadehkashi et al., 2021), which can be related to the set of additional pandemic-related challenges (e.g., the possibility of Covid-19 infection, changes in the perinatal care organization, social isolation, and economic problems) (Iyengar, Jaiprakash, Haitsuka, & Kim, 2021; Suwalska et al., 2021). That said, the Covid-19 pandemic represents a new context that offers sufficient reasons to study mental health in a community population, that could potentially be at higher risk than normal. It is therefore possible to explore how a clinical and specific aspect, such as PTSD symptomatology, fits into this cohort of pregnant women. In fact, PTSD, compared with mood and anxiety disorders, is less investigated in the perinatal era (Moran Vozar et al., 2021; Onoye et al., 2013), even if its presence and impact are however confirmed in the literature (Young & Ayers, 2021). In the abovementioned period, data on PTSD prevalence rates show a great existing variability. The prevalence rate ranges from 0 to 21% in community samples, and it changes in specific conditions: for example, in high-risk pregnancies (HRPs) it varies from 0 to 43%, and the few data available in the context of Covid-19 pandemic (Ding, & Guo, 2020; Hessami et al., 2020; Liu, Erdei, & Mittal, 2021; Molgora & Accordini, 2020), points out how prevalence rates on maternal mental disorders are higher than usual registered (Howard, & Khalifeh, 2020; Yildiz et al., 2017), so that it has been hypothesized a comparison with the general literature on high-risk perinatal groups (Erickson et al., 2022; Molgora & Accordini, 2020). In addition, we should note that the period that goes from pregnancy through to one year after birth is full of various and significant changes, including personal and interpersonal ones (Gao, Sun, & Chan, 2014). In accordance with this, there is also large variation over time in the proportion of women suffering from mental disorders symptoms, highlighting therefore cases in which mental health issues are transient events, and in which instead they become persistent problems (Dennis & Hodnett, 2007; Schmied et al., 2013). For this reason, we may wonder what forms can take the perinatal PTSD, seen not only in a timely manner (with prevalence rates), but in a temporal perspective. In this research field, there are very few studies which analyze PTSD trajectories based on longitudinal measures (Dikmen-Yildiz et al., 2018; Kim et al., 2015; Malaju et al., 2022), and mostly this is done in case of traumatic childbirth (Dikmen-Yildiz et al., 2018; Malaju et al., 2022). Anyways these studies point out different distribution patterns of PTSD symptoms over time (which can be compared

with those registered in general trauma population; Bonanno, 2004; Norris et al., 2009): detecting those who never present PTSD symptoms (resilient group); those who recover from initial PTSD symptoms (recovered group); those in which the presence of PTSD symptoms is maintained over time (chronic group); and those who develop PTSD symptoms over time (delayed group). These detectable subgroups, which depend on the timing and the persistence of the PTSD symptoms, are also affected in different ways by previous and concomitant life events (already identified in the literature as risk factors for PTSD onset) (Dikmen-Yildiz et al., 2018; Malaju et al., 2022). These studied factors can be summarized as follows: obstetric and birth related variables (e.g., parity, mode of delivery, fetal outcome); psychosocial variables (e.g., affective symptoms, fear of childbirth, perceived traumatic birth, social support); socioeconomic status (e.g., income instability); and stressful life events (e.g., health risk, relational problems, domestic violence, death of loved one). So, this latter aspect contributes to the characterization of different categories of vulnerability for PTSD, indicating that the traumatic event, alongside other factors (i.e., risk factors; Dikmen-Yildiz et al., 2018; Malaju et al., 2022) can be linked to the emergence of symptoms. But, to understand and predict the symptoms' trajectory, it is necessary to consider, more deeply, the different degree of influence that these factors can have in the different pathways that PTSD in this era can take (i.e., recovering, remaining stable, or deteriorating).

Besides all this, there is a research area that aims to explore the link between maternal PTSD in the perinatal period, and future outcomes, both considering the mother herself (in terms of parenting), and the offspring (especially considering the dimension of emotional and behavioral regulation). These two outcomes are often investigated together because they are furthermore associated between them, with data that highlights temperament influences on parenting (Bates, Schermerhorn, & Petersen, 2012; Putnam, Sanson, & Rothbart, 2002; Van Ee et al., 2016), and vice-versa (Gottman, Katz, & Hooven, 1996; Kliewer et al., 2004; Morris, Cui, & Steinberg, 2013). So, going back to perinatal PTSD, evidence suggests that this symptomatology in the mother can negatively affect her parenting abilities and experiences (McDonald et al., 2011; Muzik et al., 2017; Samuelson et al., 2017), in terms of higher levels of parenting stress (Davies et al., 2008; McDonald et al., 2011), which puts her at higher risk for reaching the condition of parental burnout (Mikolajczak et al., 2018; Roskam et al., 2017). The other type of risk,

concomitant and mutually associated to the latter on parenting, is related to the possibility, for the child, of developing emotion regulation difficulties and behavioral problems due to maternal perinatal PTSD (Bosquet Enlow et al., 2011; Chemtob et al., 2010; Ionio & Di Blasio, 2014; Laor et al., 2001; Lieberman et al., 2005; Nomura & Chemtob, 2009; Parsons et al., 1990; Rosenheck & Fontana, 1998; Samuelson & Cashman, 2008; Tees et al., 2010), even if contradictory evidence are present (Cook et al., 2018).

So, what has been said so far, makes clear the need to take advantage of the Covid-19 pandemic as a stressful environment, which give to us a unique opportunity to describe maternal PTSD in the perinatal period. In particular, it is possible to detect women at risk for this symptomatology, and what trajectories are recorded in these mothers. Also, these different patterns could help us to overcome existing gaps, and better understand this mental illness in a such specific period, through the exploration of these trajectories in relation to different predictive factors, and with adverse outcomes, both on parenting and on temperamental and behavioral problems in children.

## 2.1. AIMS AND HYPOTHESIS

The first Aim of this research is to evaluate perinatal maternal PTSD of women exposed to the Covid-19 pandemic, in terms of prevalence rates at different time-points, including prepartum and postpartum (at 6 and 12 months postpartum). Given the mental health vulnerability during pregnancy (Young & Ayers, 2021), and the additional stress caused by the Covid-19 pandemic for the perinatal population (Iyengar et al., 2021; Mehdizadehkashi et al., 2021; Suwalska et al., 2021), followed by higher mental health symptoms, (Hessami et al., 2020; Liu et al., 2021; Molgora & Accordini, 2021; Yan, Ding, & Guo, 2020), we expect, considering PTSD, to find data to confirm these latest results. In particular, levels of PTSD in a community population of women facing the perinatal period during the Covid-19 pandemic, are expected to be higher than those before the Covid-19 pandemic outbreak (Yildiz et al., 2017).

The second Aim of the research is to analyze the nature and predictors of the perinatal PTSD longitudinally (taking into account the assessments done in pregnancy, and at 6 and 12 months postpartum), in order to provide a more comprehensive understanding of its features over time and of the factors which puts mothers more at risk

for post-traumatic stress psychopathology. By detecting four distinct PTSD trajectories groups over time (i.e., resilient, recovered, chronic and delayed group), we want to explore PTSD evolution in the perinatal period, experienced within the context of the Covid-19 pandemic, in order to depict any existing difference with the reference distribution already described in literature (Dikmen-Yildiz et al., 2018; Kim et al., 2015; Malaju et al., 2022). Alongside this, our goal is to investigate how the four PTSD trajectory groups identified can be related to underlying and determinants variables, compared to the associations between these predictors and the subgroups already showed in literature (in case of traumatic childbirth; Dikmen-Yildiz et al., 2018; Malaju et al., 2022). This aim will allow us to obtain more information about low- and high-risk women for perinatal PTSD in a such environmental context, as that of the Covid-19 pandemic.

Thirdly, we have hypothesized that, the four PTSD trajectories groups depicted in the previous aim, can differently predict parenting and child development outcomes. Since in literature parenting and child temperament and behavior are two aspect that affect each other (Morris, et al., 2013; Van Ee et al., 2016), we will explore them together in this aim. Firstly, given the results that show how parenting is negatively affected by the PTSD maternal symptomatology (McDonald et al., 2011; Muzik et al., 2017; Samuelson et al., 2017; Van Ee et al., 2016), we expect to find, in current research, that PTSD perinatal trajectories can differently predict parenting outcomes at 12 months postpartum. Additionally, based on available data in support of the link between PTSD and child temperament and behavior (Bosquet Enlow et al., 2011; Chemtob et al., 2010; Korja et al., 2017; Laor et al., 2001; Lieberman et al., 2005; Nomura & Chemtob, 2009; Parsons et al., 1990; Rosenheck & Fontana, 1998; Samuelson & Cashman, 2008; Samuelson et al., 2017), we will explore how different patterns of maternal PTSD (i.e., the four trajectories groups) in perinatal period impacts child temperament assessed at 6 months and behavioral problems at 12 months.

## 2.2. METHODS

### 2.2.1.    *Participants and procedure*

The current research is part of a longitudinal study project conducted by the Department of Developmental Psychology and Socialization (DPSS) of the University of Padua. The theoretical frame in which it fits is that of Prenatal Maternal Stress (PNMS).

A first phase of this study (*t0*) was carried out during the Italian lockdown, between April 8th 2020 and May 4th 2020. This phase was focused mostly on pregnant women's mental health and pregnancy concerns Covid-19-related, and it involved women with the following inclusion criteria: being pregnant at the time of compilation or have been pregnant for at least 2 weeks during the lockdown, have an Italian residence, speak fluent Italian and be at least 18 years old. 2502 pregnant women took part to this first assessment, by completing self-report measures on their well-being and mental health, through an online survey created through Qualtrics platform, and spread on social media. Exclusion criterion was represented by not having completed the survey, by reaching a sample of 2106 (84,17%) pregnant women, where a higher psychological vulnerability was highlighted.

The research second stage (*t1*) started six months after delivery, with the aim of studying the well-being, delivery, and perinatal experience of our mother sample, plus their perception of infant behavior. Here, IBQ-R was used to assess mother's perception of three dimensions of child's temperament: *surgency*, *negative affect* and *effortful control*. 1618 women in previous phase agreed to continue the study, and after having contacted them by e-mail or by phone (when they left their phone number), 830 (51,3%) women participated to the second survey, and 748 (46,23%) completed it. The assessment included a re-test of maternal well-being and mental health and added a part on birth outcomes and infant behavior. Exclusion criteria have been established at this stage: women who have not concluded their pregnancy with childbirth, who have given birth from more than two weeks at *t0*, who have had a twin pregnancy, and who have not completed the survey; thus, reaching a final sample of 643 (39,74%) women suitable to continue the study.

Twelve months after childbirth, the third phase of the research (*t2*) started with the aim of observing maternal mental health, infant behavior and development (in terms

of motor, socio-emotional, cognitive, communicative development), and parenting outcomes. In this survey the CBCL was applied to analyze the behavior of 1 year-old children, through questions for the mothers; the PSI-4-SF was used to assess participants' perception of motherhood as stressful, and the consequently parenting behaviors; and the PBA was used to investigate the parental burnout. 623 women, among those who agreed to be further contacted, answered to this phase of the study. From this initial sample, 296 participants were excluded because they did not complete the previous survey or this third survey, reaching therefore a final sample of 327 (52,49%) available for all the analysis in the current research.

At every step of the research, participants completed the assessments upon reading the written consent form and explicitly agreeing to participate. All the phasis of the present longitudinal research have been approved by the Institutional Review Board of the University of Padua.

### 2.2.2. *Methods and materials*

Considering the aims of this current research, among all the instruments administered, we will report on:

**Post-traumatic stress disorder**

The PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013) is a self-report measure with the aim of investigating the DSM-5 symptoms of PTSD, that has been administered in our research during pregnancy (*t0*), at 6 (*t1*) and 12 months (*t2*) after delivery, in its format without DSM-5 criterion A (Trauma exposure), by assessing only cluster B (Re-experiencing), cluster C (Avoidance), cluster D (Negative alterations in cognition and mood), and cluster E (Hyper-arousal). In fact, this without criterion A format is appropriate when trauma exposure is measured in other ways, like in our study. The PCL-5, through 20 items rated on 5-point scale (from 0 = "*Not at all*", to 4 = "*Extremely*"), allow us to assess the PTSD symptomatology, keeping in mind that scores between 31-33 are considered indicative of probable PTSD. To answer to aim 1 and 2 we used the PCL-5 total score as main outcome.

**PTSD's risk factors**

Based on literature review we investigated the reported PTSD's risk factors, stratified for socio-demographic, environmental, Covid-19 related, clinical-obstetric risk factors.

Some *Socio-demographic risk factors,* that we have explored during the first step of the research (*t0*), are here reported with the following possible alternatives for response: Study Qualification (elementary school license/ middle school license/ high school license/ bachelor's degree/ master's degree/ Ph.D. or specialization); Socio-Economic Status – SES (income level: low/ medium-low/ medium/ medium-high/ high); Marital Status (unmarried/ married/ cohabiting/ separated/ divorced/ widowed/ other); Age.

Other *Environmental risk factors* asked at 6 months from delivery (*t1*) are having suffered or not from Maltreatment in Childhood, from Maltreatment in Adulthood, and from Mental Disorders. In addition, in the same research phase, also Social Support is studied through the Multidimensional Scale of Perceived Social Support – MSPSS (Zimet, Dahlem, Zimet, & Farley, 1988) (composed by 12 items rated on a 7-point scale, from 1 = "*Very strongly disagree*" to 7 = "*Very strongly agree*"), which is a self-report instrument used to evaluate the degree of social support from different sources: significant others, family, and friends. Referring to available cut-off scores, we can report that score between 1 and 2.9 could be considered representative of low support; a score ranging from 3 to 5 could be considered moderate support; and a score from 5.1 to 7 could be considered as high support.

Among the environmental factors we have also included factors specifically referred to the Covid-19 pandemic. In fact, *Covid-19 related risk factors* were investigated as possible elements conducive to the emergence of PTSD symptoms. We considered, from the assessment at 6 months from childbirth (*t1*), having or not contract the Covid-19 in Pregnancy, and in the Postpartum. Furthermore, an index of Covid-19-related pregnancy concerns was calculated from 8 questions, assessed during pregnancy (*t0*), through an investigation of the degree of safety concerning some aspects of living a pregnancy during Covid-19 (e.g., medical care, the presence of the partner in the delivery room, social support in the postpartum...) on a 7-point scale (from "*Very safe*" to "*Not safe at all*").

Also, *Clinical-Obstetric risk factors* have been analyzed: Parity status (being a primiparous or a multiparous woman), Type of Delivery (non-assisted vaginal birth/ assisted vaginal birth / scheduled C-section/ emergency C-section), Problems during Delivery, and having or not Planned the Pregnancy.

### Parenting stress

The Parenting Stress Index (PSI-R) is a self-report instrument for parents of children between 1 month and 12 years, which investigates the causes and the different types of parenting-related stress. It was proposed originally by Abidin in 1983, and then some later versions followed it, up to the current: the fourth one, consisting of 120 items. In our research this questionnaire was administered at 12 months from delivery (*t2*), and in the following version: the PSI-4 Short Form, composed by 36 items which are clustered in three subscales: *Parental Distress* (*PD*), *Parent-Child Dysfunctional Interaction* (*P-CDI*), and *Difficult Child* (*DC*), forming a *Total Stress* scale. In addition, another subscale, Defensive Responding, with the goal of attesting the validity of parental responses (detecting attempts to minimize or deny the stress and difficulties of the child), has been proposed. Items can provide two types of answers: multiple choice, or 5-point scale, from 1 ("*Strongly agree*") to 5 (*"Strongly disagree"*). The aim of this questionnaire is to identify stressed parent-child dyads which are at risk, consequently, for dysfunctional parenting behaviors or children's behavioral problems. Clinically significant stress percentiles are considered starting from the $85^{th}$ percentile for the *P-CDI* scale, and, starting from the $90^{th}$ percentile for the remaining scales.

### Parental burnout

The Parental Burnout Assessment (PBA; Roskam, et al., 2018) is a self-report questionnaire composed by 23 items, rated on a 7-point scale (from "*Never*" to "*Every day*"). This instrument, administrated in the current research to mothers 12 months postpartum (*t2*) has the aim of investigating different areas of parental burnout, which are scored in the following four subscales: exhaustion in one's parental role (*EX*; *Exhaustion*), contrast with previous parental self (*CO*; *Contrast*), feelings of being fed up with one's parental role (*FU*; *Saturation*), and emotional distancing from one's children (*ED*; *Emotional Distancing*). Through the sum of the scores obtained in each subscale we can obtain an overall score of presence of parental burnout: a higher score is indicative of the presence of the syndrome. Two cutoffs, based on different analysis, are available:

building on the response scale, scores at or above 92 were indicative of parental burnout; while, by a preregistered multi-method and multi-informant analysis strategy (through several parental burnout indicators) parents were judged to have parental burnout if their score was equal to or greater than 86 (Roskam et al., 2021).

### Infants' emotion regulation

The Infant Behavior Questionnaire is a parent-report instrument to evaluate the child's temperament, whose original version is presented with 191 items (Rothbart, 1981). The IBQ was administered in our research at 6 months postpartum (*t1*) in its Very Short Form (IBQ-R VSF) composed of 37 items (Putnam et al. 2014). This version, like the original one, is designed for parents of children from 3 to 12 months, and allows us to evaluate three broad scales of temperament: *Surgency*, *Negative Affect* and *Effortful Control*. The mother is required to report the frequency with which a specific behavior of the child occurred in the last week. The answers are on a 7-point scale, where the score 1 corresponds to "*Never*" and the score 7 to "*Always*". In addition, the answer option "not applicable" is also provided to be used in the case where, during the last week, the mother has not observed the child in the situation described.

### Infants' behavioral problems

The Child Behavior Checklist (CBCL, Achenbach, & Rescorla, 2001) was administered in the present research at 12 months postpartum (*t2*) in its preschool version, which provides valuable information on specific behavioral and emotional difficulties of children ages 1½-5 years. The CBCL is a questionnaire where the parent is asked to answer 100 problem behavior items on the infant, which can be scored on seven specific syndrome scales and on three overall scales. The overall scales are: *Internalizing Problems* (consisting of the sum of the scores of the syndrome scales *Emotionally Reactive*, *Anxious/Depressed*, *Somatic Complaints*, *Withdrawn*), *Externalizing Problems* (represented by the scores of the *Attention Problems* and *Aggressive Behavior* syndrome scales), and *Total Problems* (which is given by the sum of the scores of all the items of the questionnaire). From these groupings the *Sleep Problems* syndromic scale is the only scale which remains unincluded. Parents have to rate the child's behavior, by considering the present or the last two months, on a 3-point scale ("*Not true*", "*Somewhat or sometimes true*", and "*Very true or often true*").

### 2.2.3.    *Statistical analyses*

Statistical analyses were conducted using the software R (R Core Team, 2013) and RStudio (RStudio Team, 2016). Firstly, descriptive analysis was conducted to evaluate frequency, mean, standard deviation and range of variation of socio-demographic and clinical-obstetric features of the mothers of our final sample, as well as of perinatal characteristics of the newborns.

Then, to test the first research hypothesis, we performed a calculation of the prevalence of perinatal PTSD symptomatology, at every measurement available (*t0*, *t1* and *t2*) through the percentage estimation of participants under and at or above the cut-offs of 31 and 33 in the PCL-5 questionnaire.

For the second hypothesis, we used the PTSD prevalence at the different time-points assessments, to detect perinatal PTSD trajectories over time (from pregnancy to 12 months from delivery) to form four PTSD groups. Group differences concerning differential effects of PTSD risk factors were examined using Chi-square measure for categorical variables, and Multivariate Linear Regression Model for continuous measures.

To test the third hypothesis of this research we performed a Multivariate Linear Regression Model, using PTSD trajectories as predictor for parenting and child development outcomes. Analysis was controlled for possible confounding factors related to socio-demographic features (age, SES, study qualification, mental disorders, maltreatment in childhood, and in adulthood), and experiences related to past and actual pregnancy (parity, and Covid-19 related pregnancy concerns). In fact, these variables, and especially history of mental health problems, significantly influence levels of PTSD symptoms, given that their role as risk factors for perinatal PTSD is well studied in this research field (Grekin, & O'Hara, 2014; Howard et al., 2014; Malaju et al., 2022; Molgora & Accordini, 2020; Ross & McLean, 2006).

## 2.3. RESULTS
### 2.3.1.    *Sample characteristics*

Our final sample consists of 327 mothers followed from pregnancy to 12 months after childbirth, considering as crucial in the screening process the completion of the PCL-

5 questionnaire in the various stages of our research (for this reason, those mothers whose data in at least one step of the research were missing or incomplete, were excluded). Using the PCL-5 total scores and choosing to consider the cut-off 31, our target population can be grouped in four different PTSD patterns over time. Indeed, by choosing a more conservative cut-off of PTSD, we can maximize the detection of possible cases of PTSD, which is important to consider, both for maternal mental health, and also for any future implications regarding the offspring and the mother-child relationship.

The participant's selection is displayed in Figure 1 and it is described below:

- Resilient-PTSD (n= 226, 69.1%): women who never showed a PTSD symptomatology (score always below the PCL-5 cut-off) at any assessment.

- Delayed-PTSD (n= 48, 14.6%): women who registered a PTSD symptomatology (at or above the PCL-5 cut-off) in at least one timepoint assessment after childbirth (at 6 months or at 12 months postpartum, or in both postpartum measurements), but not in the pregnancy assessment.

- Chronic-PTSD (n= 21, 6.4%): women who registered a score for PTSD symptomatology at or above the PCL-5 cut-off at every assessment, meaning that these symptoms were stable high from pregnancy to 12 months postpartum. But we also included in this group a small number of participants (n=5) who had a score above the cut-off both in pregnancy and at 12 months postpartum, but not at 6 months from childbirth.

- Recovered-PTSD (n= 32, 9.7%): women who registered a PTSD symptomatology in pregnancy, which was recovered within 12 months postpartum; including in this way both women who had or not a score above the PCL-5 cut-off at 6 months postpartum.

*Figure 1*. Flowchart of participants



Figure 1. Flowchart of participants
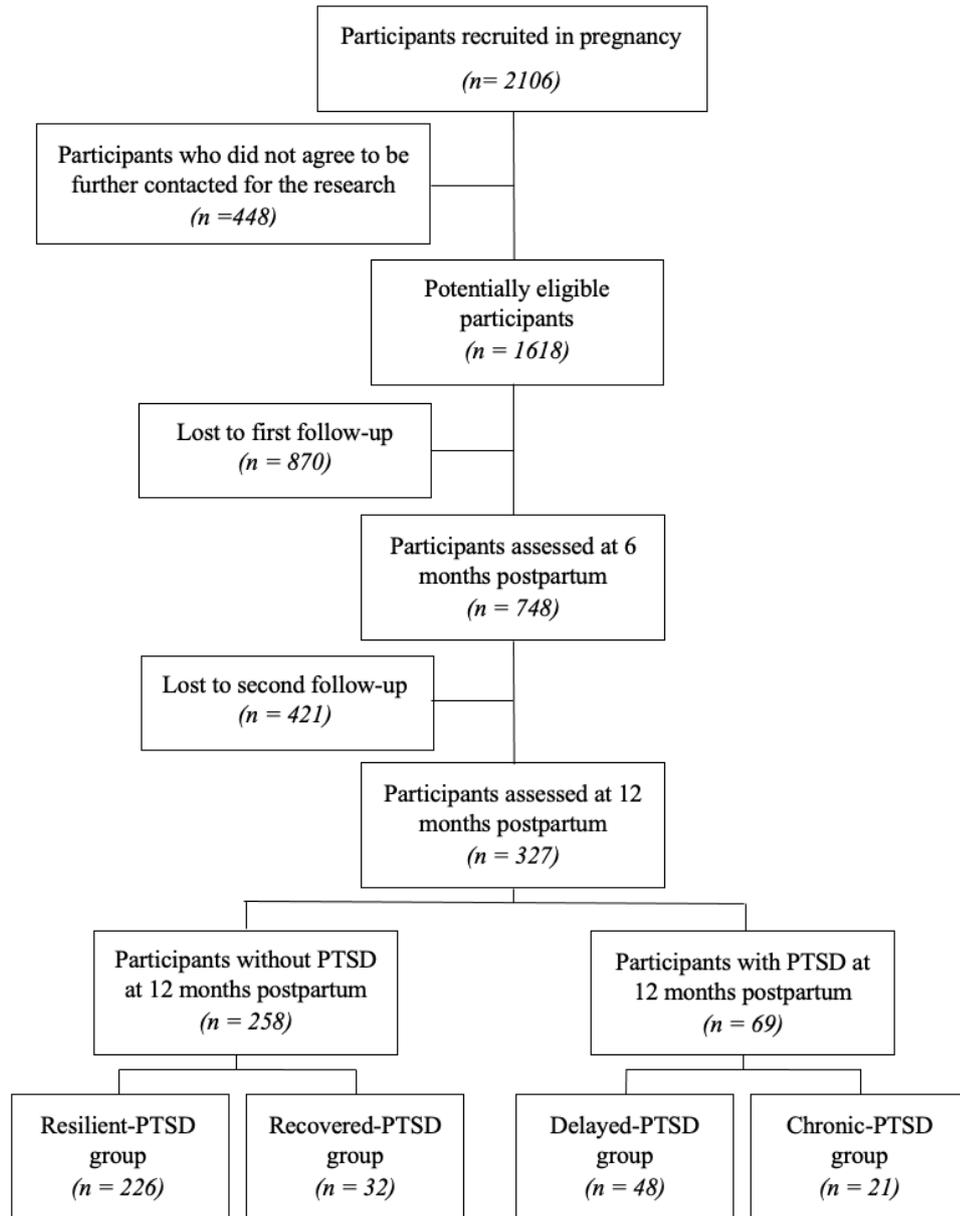
Participants' characteristics in terms of socio-demographic information, clinical-obstetric characteristics, and perinatal features are reported in Table 1.

*Table 1*. Study participants' socio-demographic, clinical-obstetric and perinatal characteristics (n= 327)

| Variables | Values |
|---|---|
| **Socio-demographic variables** | |
| **Age,** mean, sd (range) | 32.87, 4.34 (22-46) |
| **Nationality,** N (%) | |
| Italian | 320 (98.1%) |
| Other | 6 (1.8%) |
| **Region,** N (%) | |
| North | 251 (77.7%) |
| Central | 45 (13.9%) |
| South and Islands | 27 (8.3%) |
| **SES,** N (%) | |
| Low (<12.000 € income) | 14 (4.2%) |
| Medium-low (12.000-25.000 € income) | 71 (21.7%) |
| Medium (25.000-50.000 € income) | 194 (59.5%) |
| Medium-high (50.000-75.000 € income) | 40 (12.2%) |
| High (>75.000 € income) | 7 (2.1%) |
| **Study qualification** | |
| Middle school license | 8 (2.4%) |
| High school license | 99 (30.2%) |
| Bachelor's degree | 85 (25.9%) |
| Master's degree | 105 (32.1%) |
| Ph.D. or specialization | 30 (9.1%) |
| **Marital status,** N (%) | |
| Unmarried | 12 (3.7%) |
| Married | 198 (61.4%) |
| Cohabiting | 110 (34.1%) |
| Divorced | 2 (0.6%) |
| **Clinical-obstetric variables** | |
| **Planned pregnancy** N (%) | |
| No | 54 (16.5%) |
| Yes | 273 (83.4%) |
| **Previous Pregnancies,** N (%) | |
| No | 226 (69.1%) |
| Yes | 101 (30.8%) |
| **Parity status**, N (%) | |
| Primiparous | 250 (76.9%) |

| | |
|---|---|
| Multiparous | 75 (23%) |
| **Miscarriages** N (%) | |
| No | 255 (79.4%) |
| Yes | 66 (20.5%) |
| **Gestational period at *t0*,** mean, sd (range) | 27, 8.8 (5-40) |
| **Trimester of Pregnancy at *t0*** N (%) | |
| First trimester | 30 (9.1%) |
| Second trimester | 104 (31.8%) |
| Third trimester | 179 (54.7%) |
| Given birth less than 2 weeks | 14 (4.2%) |
| **Disorders of current Pregnancy** N (%) | |
| No | 301 (92.3%) |
| Yes | 25 (7.6%) |
| **Type of Delivery** N (%) | |
| Non-assisted vaginal birth | 51 (15.5%) |
| Assisted vaginal birth | 197 (60.2%) |
| Scheduled C-section | 36 (11%) |
| Emergency C-section | 43 (13.1%) |
| **Problems during Delivery** N (%) | |
| No | 237 (72.4%) |
| Yes | 90 (27.5%) |
| **Perinatal variables** | |
| **Gestational age at birth** mean, sd (range) | 39.8, 1.4 (31.4-42.2) |
| **Infants' sex** N (%) | |
| Male | 168 (51.6%) |
| Female | 157 (48.3%) |
| **Infants' weight** mean, sd (range) | 3301 g, 490.2 (1400-4568) |

### 2.3.2. *Variables of interest description*

Descriptive statistics of our variables of interest are showed in the following table (Table 2).

*Table 2. Study participants' characteristics studied as risk factors (n= 327)*

| Variables | Values |
|---|---|
| **Risk factors variables** | |
| **Having suffered from maltreatment in childhood** N (%) | |
| No | 288 (90.8%) |
| Yes | 29 (9.1%) |
| **Having suffered from maltreatment in adulthood** N (%) | |
| No | 282 (88.9%) |
| Yes | 35 (11%) |
| **Having suffered from mental disorders** N (%) | |
| No | 293 (92.4%) |
| Yes | 24 (7.5%) |
| **Perceived Social Support,** mean, sd (range) | 4.8, 0.8 (1.1-6) |
| **Having contracted Covid-19 during pregnancy**, N (%) | |
| No | 317 (96.9%) |
| Yes | 10 (3%) |
| **Having contracted Covid-19 during postpartum**, N (%) | |
| No | 304 (92.9%) |
| Yes | 23 (7%) |
| **Covid-19 related Pregnancy concerns**, mean, sd (range) | 35.1, 10 (8-56) |
| **Outcomes variables** | |
| **Parenting Stress Index (Total score) at *t2*,** mean, sd (range) | 67.8, 17.2 (34-121) |
| **Parental Burnout Assessment (Total score) at *t2*,** mean, sd (range) | 18.5, 21.9 (0-127) |
| **IBQ (Negative Affect score) at *t1*,** mean, sd (range) | 40.9, 11.9 (9-71) |
| **CBCL (Total Problems score) at *t2*,** mean, sd (range) | 13.4, 15.7 (0-115) |

By continuing to explore our variables of interest, Figure 1 shows the distribution of the main variables of the study.

*Figure 1*. *Histogram of PCL-5 (Total score) distribution, at different time-points, in the final sample (n=327)*

**PCL-5 distribution at t0**



**PCL-5 distribution at t1**



**PCL-5 distribution at t2**
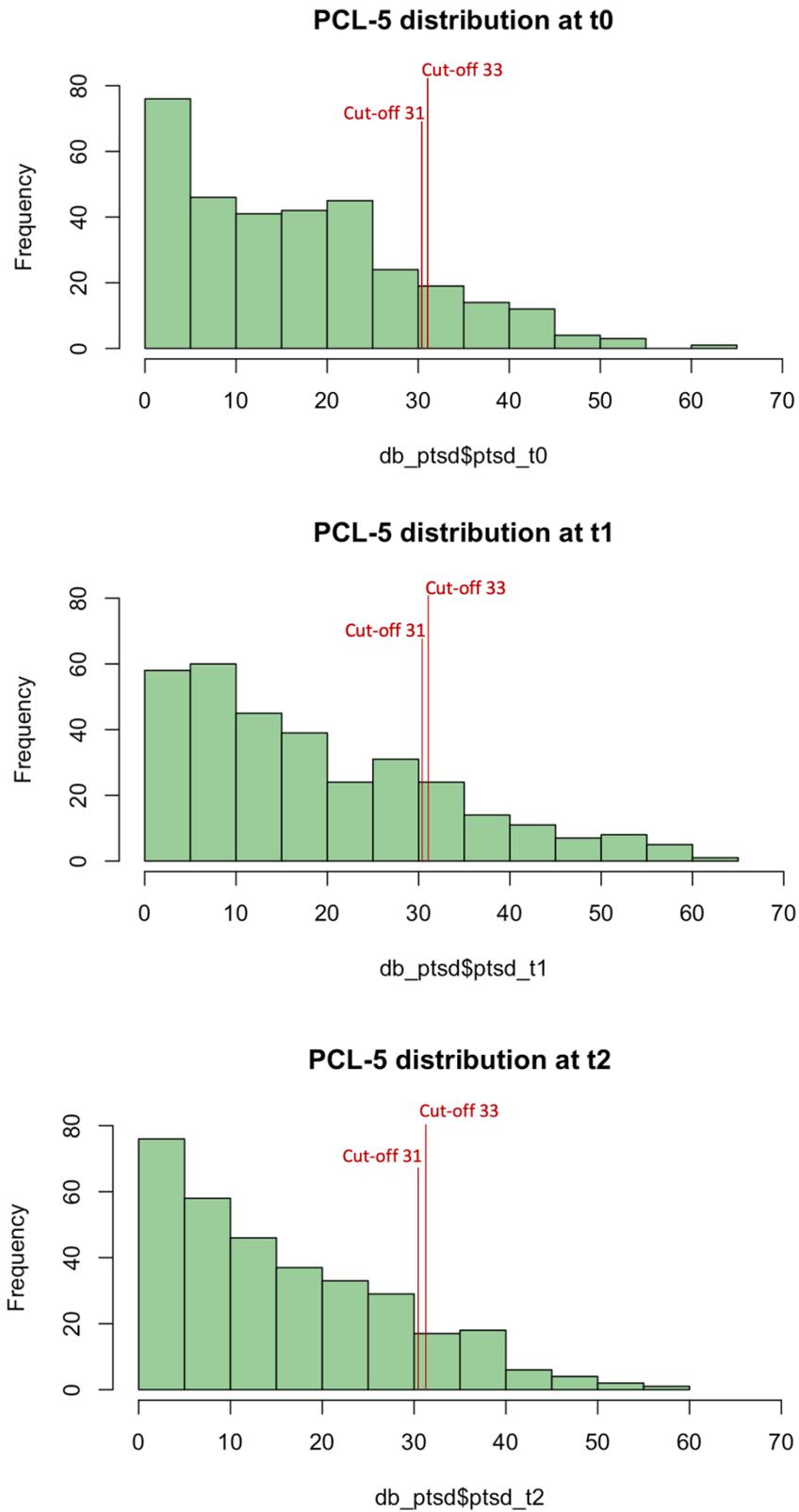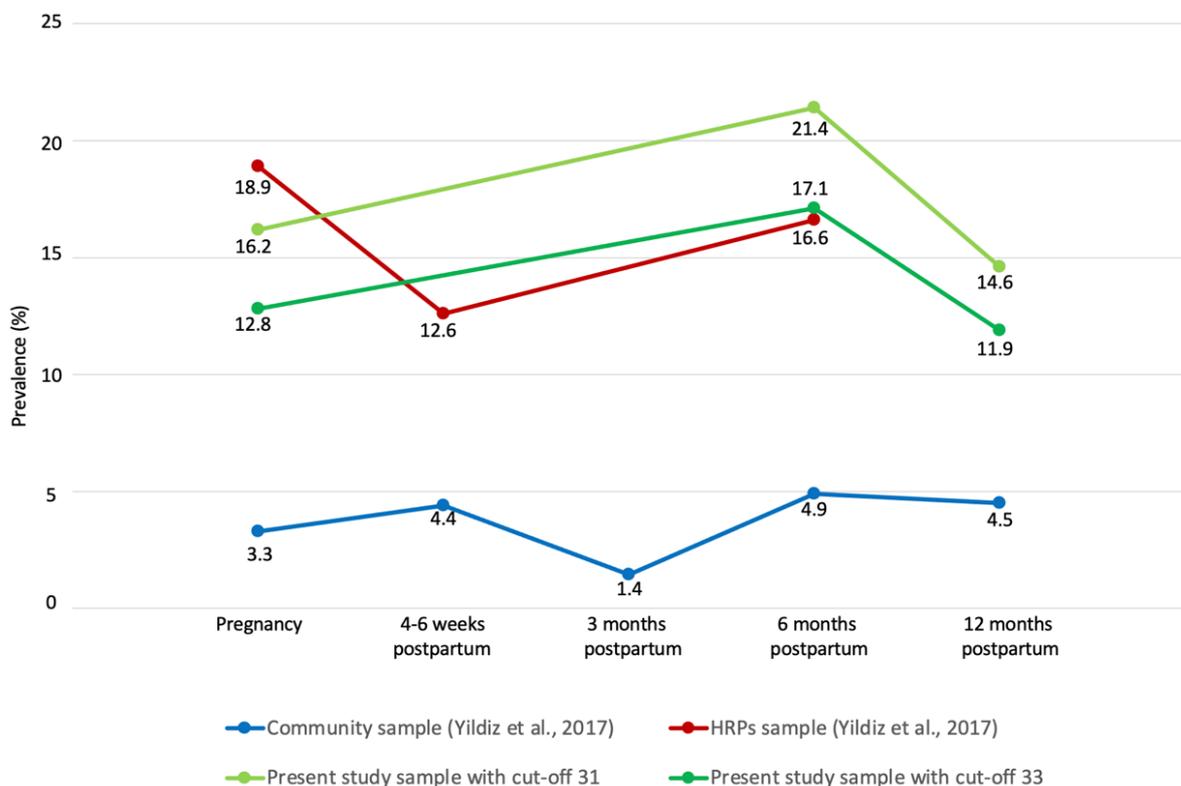
### 2.3.3. Data analysis Aim 1

To explore the PTSD symptomatology of our sample at different time-points assessments, an observation of the prevalence score (N, %) at or above the 31 and the 33 cut-offs at PCL-5 questionnaire, was performed. Table 3 displays our results.

**Table 3.** *Perinatal PTSD prevalence at different time-points considering the PCL-5 total score at or above the cut-off=31 and the cut-off=33 (n=327)*

|  | *t0* | *t1* | *t2* |
|---|---|---|---|
| PCL-5 **(cut-off 31)**, N (%) | 53 (16.2%) | 70 (21.4%) | 48 (14.6%) |
| PCL-5 **(cut-off 33)**, N (%) | 42 (12.8%) | 56 (17.1%) | 39 (11.9%) |

Then, we graphically compared our results with previous available data, summarized in a systematic review and meta-analysis (Yildiz et al., 2017), in Figure 2.

**Figure 2**. *Perinatal PTSD prevalence data over time of our sample (n=327) compared with the literature (Yildiz et al., 2017)*

### 2.3.4. Data analysis Aim 2

After having graphically represented the four PTSD trajectories groups, by taking into account the PCL-5 mean score of each group at the different assessments (Figure 3), we applied similar strategy as for Aim 1, comparing PTSD patterns over time with available data (Dikmen-Yildiz et al., 2018; Kim et al., 2015; Malaju et al., 2022). Results are showed in Table 4.

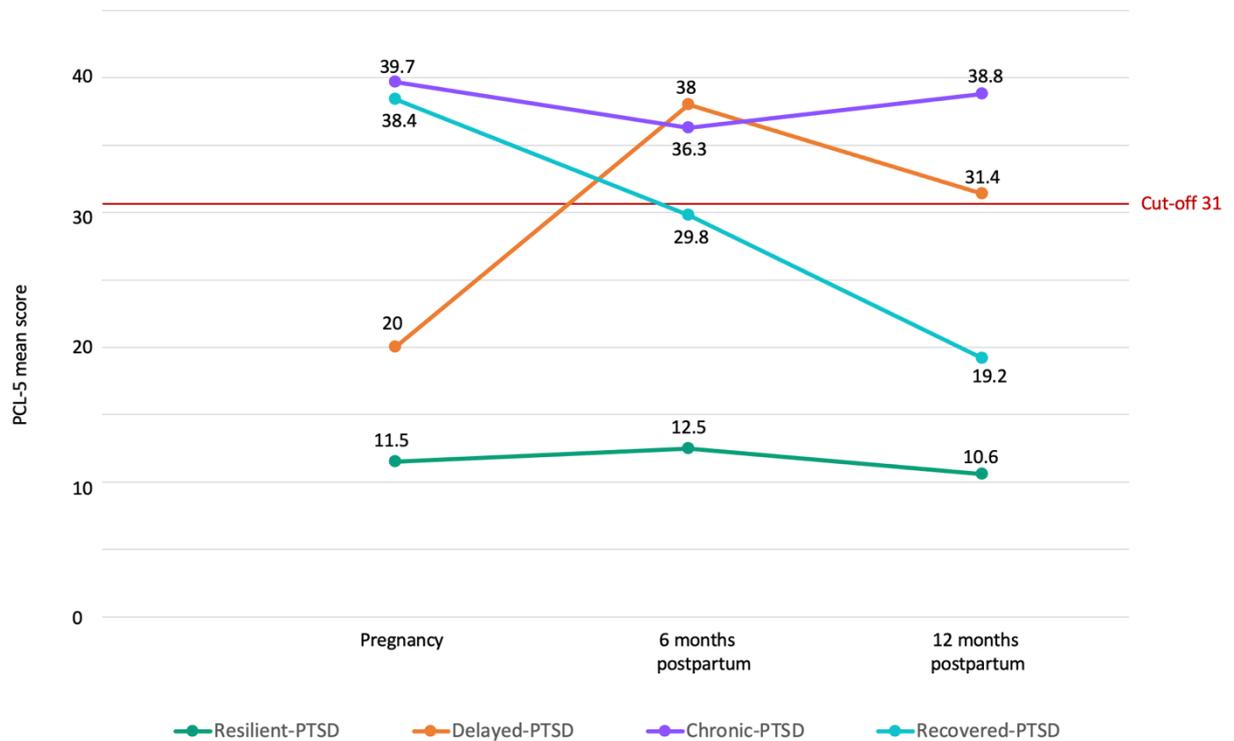*Figure 3. PCL-5 mean score of the four PTSD trajectories groups*

*Table 4. Perinatal PTSD patterns over time of our sample, compared with the literature (Dikmen-Yildiz et al., 2018; Kim et al., 2015; Malaju et al., 2022)*

| | Community sample | | HRPs sample | Present study sample |
|---|---|---|---|---|
| | *Dikmen-Yildiz et al. (2017)* | *Malaju et al. (2022)* | *Kim et al. (2015)* | |
| **Resilient**, N (%) | 140 (61.9%) | 683 (88%) | 87 (66.9%) | 226 (69.1%) |
| **Delayed**, N (%) | 13 (5.7%) | - | 12 (9.2%) | 48 (14.6%) |
| **Chronic**, N (%) | 31 (13.7%) | 50 (6.5%) | 12 (9.2%) | 21 (6.4%) |
| **Recovered**, N (%) | 42 (18.5%) | 42 (5.4%) | 19 (14.6%) | 32 (9.7%) |
| | t= pregnancy, 4-6 weeks, and 6 months postpartum | t= 6, 12, and 18 weeks postpartum | t= 1, 3, and 12 months postpartum | t= pregnancy, 6, and 12 months postpartum |
| | n= 226 | n= 775 | n= 130 | n= 327 |

After that, we analyzed the effect of underlying risk factors, previously exposed, in the four different groups. Predictors of the PTSD trajectory group membership which were studied are presented in Table 6, by specifying the variable distribution in the participants included in the different patterns of PTSD, and those variables which were found to be statistically significant in our analyses. From these analyses we can see how our findings confirm only partially what is indicated in the literature: only the variables of perceived social support, maltreatment in childhood, maltreatment in adulthood, mental disorders and unplanned pregnancy show a statistically significant differential effect on PTSD depending on the trajectory group considered; also, an effect that tends towards statistical significance is represented by Covid-19 related Pregnancy concerns ($p=.060$).

***Table 6****. Risk factors of PTSD trajectories*

| | Resilient-PTSD (*n= 226*) | Delayed-PTSD (*n=48*) | Chronic-PTSD (*n= 21*) | Recovered-PTSD (*n= 32*) | P-value |
|---|---|---|---|---|---|
| **Age**, mean, sd (range) | 33.1, 4.1 (22-44) | 31.9, 4.5 (24-46) | 32.4, 4.5 (23-44) | 32.7, 4.8 (22-45) | .33 |
| **Study qualification**, N (%) | | | | | .12 |
| Middle school license | 3 (1.3%) | 3 (6.2%) | 2 (9.5%) | - | |
| High school license | 64 (28.3%) | 13 (27.08%) | 10 (47.6%) | 12 (37.5%) | |
| Bachelor's degree | 60 (26.5%) | 14 (29.1%) | 5 (23.8%) | 6 (18.7%) | |
| Master's degree | 75 (33.1%) | 16 (33.3%) | 3 (14.2%) | 11 (34.3%) | |
| Ph.D. or specialization | 24 (10.6%) | 2 (4.1%) | 1 (4.7%) | 3 (9.3%) | |
| **SES**, N (%) | | | | | .33 |
| Low (<12.000 € income) | 5 (2.2%) | 3 (6.2%) | 3 (14.2%) | 3 (9.3%) | |
| Medium-low (12.000-25.000 € income) | 46 (20.44%) | 13 (27%) | 5 (23.8%) | 7 (21.8%) | |
| Medium (25.000-50.000 € income) | 139 (61.7%) | 25 (52%) | 12 (57.1%) | 18 (56.2%) | |

| | | | | | |
|---|---|---|---|---|---|
| Medium-high (50.000-75.000 € income) | 29 (12.8%) | 6 (12.5%) | 1 (4.7%) | 4 (12.5%) | |
| High (>75.000 € income) | 6 (2.6%) | 1 (2%) | - | - | |
| **Marital status**, N (%) | | | | | .80 |
| Unmarried | 8 (3.5%) | 3 (6.8%) | 1 (4.7%) | - | |
| Married | 138 (61.3%) | 27 (61.3%) | 12 (57.1%) | 21 (65.6%) | |
| Cohabiting | 78 (34.6%) | 13 (29.5%) | 8 (38%) | 11 (34.3%) | |
| Divorced | 1 (0.4%) | 1 (2.2%) | - | - | |
| **Maltreatment in childhood (yes)**, N (%) | 12 (5.4%) | 6 (13%) | 5 (25%) | 6 (19.3%) | .002 |
| **Maltreatment in adulthood (yes)**, N (%) | 17 (7.2%) | 8 (17.3%) | 3 (15%) | 7 (22.5%) | .031 |
| **Mental disorders (yes)**, N (%) | 9 (4%) | 9 (19.5%) | 2 (10%) | 4 (12.9%) | .002 |
| **Perceived Social Support**, mean, sd (range) | 5, 0.75 (1.1-6) | 4.6, 0.9 (1.3-6) | 4.1, 0.6 (3-5.1) | 4.4, 0.8 (2.7-5.9) | <.001 |
| **Having contracted Covid-19 during pregnancy (yes)**, N (%) | 7 (3%) | - | 2 (9.5%) | 1 (3.1%) | .68 |
| **Having contracted Covid-19 during postpartum (yes)**, N (%) | 12 (5.3%) | 6 (12.5%) | 1 (4.7%) | 4 (12.5%) | .18 |

| | | | | | |
|---|---|---|---|---|---|
| **Covid-19 related Pregnancy concerns**, mean, sd (range) | 34.3, 9.7 (8-56) | 37.1, 10 (16-55) | 42, 10.7 (9-54) | 37.8, 10.2 (18-56) | .060 |
| **Planned Pregnancy (no),** N (%) | 31 (13.7%) | 10 (20.8%) | 8 (38%) | 5 (15.6%) | .029 |
| **Parity status**, N (%) | | | | | .59 |
| Primiparous | 176 (78.5%) | 37 (77%) | 15 (77.4%) | 22 (68.7%) | |
| Multiparous | 48 (21.4%) | 11 (22.9%) | 6 (28.5%) | 10 (31.2%) | |
| **Type of Delivery**, N (%) | | | | | .65 |
| Non-assisted vaginal birth | 30 (13.2%) | 9 (18.7%) | 4 (19%) | 8 (25%) | |
| Assisted vaginal birth | 138 (61%) | 30 (62.5%) | 12 (57.1%) | 17 (53.1%) | |
| Scheduled C-section | 29 (12.8%) | 4 (8.3%) | 1 (4.7%) | 2 (6.2%) | |
| Emergency C-section | 29 (12.8%) | 5 (10.4%) | 4 (19%) | 5 (15.6%) | |
| **Problems during Delivery (yes)**, N (%) | 62 (27.4%) | 16 (33.3%) | 5 (23.8%) | 7 (21.8%) | .68 |

### 2.3.5.  *Data analysis Aim 3*

To investigate the role of perinatal PTSD as predictor of parenting and child development outcomes, we firstly explored the participants' outcomes distribution for each PTSD trajectory group. Then, a Multivariate Linear Regression Model was performed controlling for the abovementioned confounding factors. From the findings displayed in Table 7, we can say that for our sample the fact of being part of a specific PTSD trajectory group has a differential effect, which is statistically significant for Parenting Stress and Parental Burnout. While, on the child development outcomes here investigated a significant effect of PTSD trajectories over time was not found.

***Table 7.*** *Multivariate Linear Regression Model between Perinatal PTSD and parenting (Parenting Stress Index Total score; Parental Burnout Assessment Total score) and child development (Negative Affect from IBQ; Total Problems from CBCL) outcomes*

| | *Outcomes* | **Resilient-PTSD** (*n= 226*) | **Delayed-PTSD** (*n=48*) | **Chronic-PTSD** (*n= 21*) | **Recovered-PTSD** (*n= 32*) | P-value | P-value adjusted* | Cohen's d |
|---|---|---|---|---|---|---|---|---|
| *Parenting* | **Parenting Stress** (Tot score), mean, sd (range) | 63.4, 16 (34-118) | 77.5, 16.6 (45-121) | 84.5, 10.2 (67-100) | 73.6, 16 (38-98) | <.001 | <.001 | >1 |
| | **Parental Burnout** (Tot score), mean, sd (range) | 12.6, 14.4 (0-79) | 27.2, 28.7 (0-127) | 45.1, 31.4 (2-101) | 27.4, 25.2 (0-104) | <.001 | <.001 | >1 |
| *Child development* | **Negative Affect** (IBQ), mean, sd (range) | 40.1, 11.6 (13-68) | 43.4, 11.6 (20-71) | 44.4, 12.6 (23-70) | 40.1, 13 (9-59) | .16 | .62 | .36 |
| | **Total Problems** (CBCL), mean, sd (range) | 12.4, 15.7 (0-115) | 14, 12.2 (0-53) | 16.5, 11.5 (2-39) | 17.5, 22.2 (0-110) | .38 | .51 | .33 |

*\*p-value calculated with the depicted confounding factors*

## *2.4. DISCUSSION*

The current study is proposed as a new empirical contribution to the multitude of studies, carried out in the theoretical frame of PNMS, which highlight the vulnerability of prenatal period, both for woman's health and offspring development (Davis & Sandman, 2010; Erickson et al., 2022; Glover et al., 2018; Lequertier, 2018; Stein et al., 2014; Young & Ayers, 2021). Adverse consequences in terms of maternal and infant morbidity (Stein et al., 2014; Young & Ayers, 2021) are also associated with problems in maternal psychological well-being, which can be exacerbated based on the fact that the perinatal period is a phase characterized by important biological and psycho-social changes (Bjelica et al., 2018; Gao et al., 2014). Our results show that, in a cohort of pregnant women during the first Covid-19 Italian lockdown, PTSD prevalence rates over time are higher than previous data, even if perinatal longitudinal pathways highlight some crucial similarities with literature. Then, our study confirmed the already well-known PTSD association with parenting experience and abilities, but, considering already available results, also contradicting evidence are collected in terms of PTSD's predictors and child development outcomes.

### *2.4.1.    Maternal perinatal PTSD in pandemic era*

Our results were in line with our hypothesis of a higher PTSD prevalence during Covid-19 pandemic. This outcome is coherent with the fact that pregnancy is a risk factor for maternal mental health (Young & Ayers, 2021), and additional stressors are also detectable during the first postpartum year, across transition to parenthood (Gao et al., 2014). The physical, environmental, and emotional demands that motherhood requires can be really challenging and they may represent an important stress source for the woman. When the demand exceeds the individual's resources and it is felt like prolonged and uncontrollable, the woman may develop, after an initial adaptive response to stress, post-traumatic stress symptoms, with its consequently deleterious implications (Erickson et al., 2022). So, for the reasons just mentioned, it is evident the need of complement the corpus of knowledge related to perinatal PTSD, which, in this specific period, is less investigated than mood and anxiety disorders (Moran Vozar et al., 2021; Onoye et al., 2013). A unique condition that strengthens this need is the environmental context of

Covid-19 pandemic, which can be distressing for everyone, and especially for those who may be particularly vulnerable to intense worries or distress about the pandemic, such as pregnant women (Brooks, Weston, & Greenberg, 2020c; Caparros-Gonzalez, & Alderdice, 2020; Erickson et al., 2022; Manchia et al., 2022). In fact, based on preliminary findings (Ding, & Guo, 2020; Hessami et al., 2020; Liu et al., 2021; Molgora & Accordini, 2020), which show how prevalence rates of perinatal mental disorders increased during the Covid-19 pandemic, we investigated longitudinally the number of women with clinical levels of PTSD from pregnancy to one year after delivery. Firstly, in accordance with data from community and HRPs samples (Yildiz et al., 2017), we found that PTSD prevalence rises at 6 months postpartum, as opposed to how it does in non-perinatal groups (Morina, Wicherts, Lobbrecht, & Priebe, 2014). This specific outcome could be explained through the unique features of the perinatal period (e.g., manage with the newborn and with sleep deprivation), that might be responsible for a delay in symptoms onset or in their resolution (Garthus-Niegel, Ayers, von Soest, Torgersen, & Eberhard-Gran, 2015). Another data interpretation is that a possible traumatic childbirth could have been happened, which could be, during postpartum, the origin of PTSD onset, or the re-trigger given a history of PTSD (Yildiz et al., 2017).

Besides this, the registered prevalence rates in our sample highlights, as expected in the first hypothesis, higher levels of PTSD among a community cohort of women in the perinatal period, compared to available data prior to Covid-19 pandemic (Yildiz et al., 2017). Our PTSD prevalence rates are actually more comparable to those belonging to HRPs samples, showing that the Covid-19 pandemic should be not underestimated in terms of psychological impact (Brooks et al., 2020c), and therefore should be considered as a type of traumatic stress (such as birth trauma, which is one of the most studied phenomena in reference to PTSD postpartum) (Erickson et al., 2022; Yildiz et al., 2017). In particular, what could have overloaded the psychological functioning of pregnant women is a series of stressful conditions related to the pandemic, such as its unpredictable course, the wide range of possible manifestations of the disease, the continuous changes in the various limitations imposed, the alterations in perinatal medical care, and the increase in financial difficulties and in the risk of domestic and intimate partner violence (Iyengar et al., 2021; Royal College of Obstetrics and Gynaecologists [RCOG], 2022; Suwalska et al., 2021). Also, considering that social support is a well-known successful

coping strategy in stressful conditions, that helps to maintain resilience, and that predict negative psychological outcomes when it is compromised, we can suppose that, the required pandemic-related shifts in behavior, in terms of social distancing, could have been relevant in determining this worsening of PTSD symptoms (Brooks, Amlôt, Rubin, & Greenberg, 2020a; Brooks et al., 2020c; Goldmann & Galea, 2014; Van Bavel et al., 2020). So, as already hypothesized and supported by the emerging evidence on perinatal maternal mental health during Covid-19 pandemic (Erickson et al., 2022; Molgora & Accordini, 2021), we can affirm that, sustained by our reported data on PTSD levels, pregnancies exposed to the Covid-19 pandemic can represent a high-risk group. Our results are aligned with previous studies on pregnant women during pandemics (e.g., the 1918 flu pandemic) and their offspring's longer-term consequences (Helgertz & Bengtsson, 2019; Lam et al., 2004; Mosby, Rasmussen, & Jamieson, 2011). That said, being pregnant during an emerging infectious disease outbreak may negatively affect maternal mental health, putting at higher risk a group already vulnerable under normal conditions (i.e., community samples of pregnant women), which could explain our sample's higher rates in terms of perinatal PTSD prevalence.

### 2.4.2. *Perinatal PTSD features: different trajectories and predictors*

The second aim of this research was to explore the evolution of perinatal PTSD longitudinally, alongside with factors that predict its course over time. Data collected in our study confirm two main results already depicted in previous evidence (Dikmen-Yildiz et al., 2018; Kim et al., 2015; Malaju et al., 2022): firstly, women's response to the perinatal challenges is not homogeneous and is likely to follow four different paths (i.e., resilient, delayed, chronic, recovered). This is in accordance firstly with the fact that the perinatal period is characterized by different personal and interpersonal changes (Gao et al., 2014), that can be therefore faced differently depending on the individual and the specific moment considered. In fact, not everybody who experiences a traumatic event will develop PTSD, even in high-risk groups (Ayers & Ford, 2016), because individual vulnerability features have to be combined with different predisposing or precipitating factors (i.e., birth and postpartum factors, cognitive appraisals and coping strategies), obtaining thus so many different symptomatology's trajectories. The second result in

accordance with the literature is the fact that the biggest trajectory group is represented by the resilient one, corresponding to about two-thirds of the final sample (69.1%). These two results are not surprising if we consider the trajectories of other indicators of perinatal mental health (i.e., perinatal anxious and depressive symptoms). In fact, when they are observed longitudinally, they can be easily divided in different subgroups, depending on onset timing and symptoms' persistence, and the largest trajectory group is represented by the resilient one, suggesting that the healthy trajectory may be normative (Ahmed, Feng, Bowen, & Muhajarine, 2018; Baron, Bass, Murray, Schneider, & Lund, 2017; Santos, Tan, & Salomon, 2017; Wikman et al., 2020). Our results show that even if the registered PTSD prevalence rates in the present study are higher than usually registered in community samples of pregnant women (Yildiz et al., 2017), the proportion of women that never manifest post-traumatic stress symptoms in the investigated period is respected in the present study, like it was respected also in HRPs cohorts (Kim et al., 2015). We can therefore affirm that, even if it exists a real risk in perinatal era for mental illness, that can be heightened by the pandemic situation, the majority of women are anyways resilient (Young & Ayers, 2021). The general tendency to resilience can be explained by referring to the fact that in perinatal literature it is well-recognized that pregnancy, birth, and the transition to parenthood represent a set of challenges with the potential for adaptation, resilience, and growth, depending on various interacting systems (Young & Ayers, 2021).

However, considering the remaining three PTSD trajectories groups here identified (i.e., delayed, chronic and recovered), thus referring to women who have at least in a time-point manifested clinically significant levels of PTSD, there are some of these mothers more at risk than others, and especially with different prognoses. The smallest group of 6.4% represents those who registered stable high levels of PTSD (i.e., chronic), followed by the 9.7% of those with early PTSD onset which then recovered (i.e., recovered), and, lastly by the 14.6% of mothers which had a delayed PTSD onset, that have failed to recover (i.e., delayed). These percentages, if compared to the literature ones, show some differences, that should be treated by taking into account the fact that the two reference studies on community cohorts (Dikmen-Yildiz et al., 2018; Malaju et al., 2022) evaluate the PTSD symptoms respectively up to 6 and 4 months postpartum, and only the study on an HRPs cohort (Kim et al., 2015) reaches a 12 months postpartum assessment, as in the current study. The first difference that we could analyze regards the

fact that in the current research there are fewer women with chronic PTSD. This outcome could be explained by the fact that our participants were not selected based on having or not a traumatic childbirth (Dikmen-Yildiz et al., 2018; Malaju et al., 2022) or an infant hospitalization in NICU (Kim et al., 2015), but they just represent a community sample in the Covid-19 era. Secondly, a self-selection bias is possible, which is not an infrequent explanation in case of human stress studies (Alarie & Lupien, 2021), and we could in fact hypothesize that those who did not complete all the three assessments may represent a more vulnerable group in terms of psychological distress. In the current study we have also registered, compared to existing literature, a greater presence of delayed-PTSD and a smaller number of mothers who recovered from PTSD. A possible explanation of these different distributions is given by the fact that, as said before, the normative response in the long term to stress is resilience, but probably, given the fact that the global pandemic caused by Covid-19 has lasted longer than expected at the beginning, we are observing something equally unexpected. Indeed, the initial demands and concerns caused by the Covid-19 pandemic have become really challenging when, instead of decreasing, they have been maintained over time, becoming a form of chronic stress (Manchia et al., 2022). In a similar situation, some of the women who could have been part of the resilient group may have developed PTSD symptoms in response to traumatic events (such as traumatic childbirth). In the same way, trying to interpret the percentage of the recovered-PTSD group, the psychological recover usually attended might be more difficult in the pandemic situation, considering a vulnerable population like the pregnant one (Manchia et al., 2022). In fact, adding to the several psycho-social tasks that women in perinatal period have to overcome the stress to manage the pandemic and its tiring consequences, few psychological resources remain available to recover the already emerged PTSD symptoms.

Additionally, this research extends our knowledge about factors involved in the development and trajectory of perinatal PTSD by investigating the PTSD's risk factors already reported in the literature. From the statistical analyses conducted in the present study, we observed a significant differential effect between the PTSD trajectories groups, for only few variables. But firstly, seen the small number of women belonging to the different subgroups (except for the resilient one), caution is necessary for the interpretation of the findings that we are about to discuss. So, as our results showed,

among the socio-demographic factors, (i.e., age, education, income, and marital status) none of those was linked to the PTSD trajectories. This can be interpretated considering the fact that we don't have a heterogeneous distribution for age, income and marital status, since age distribution is almost overlapping in the different trajectories groups, most of the women have a medium income (between 25.000 and 50.000 €) and are married. Also, there was already poor evidence in literature of the effect of these four socio-demographic variables on maternal perinatal PTSD, compared to other factors that we are about to mention (Ayers & Ford, 2016). In fact, all the risk factors labeled in the present study as environmental (i.e., history of maltreatment in childhood, in adulthood, mental disorders, and perceived social support in postpartum period), including events prior to the perinatal period and concomitant to this, were confirmed as significant PTSD predictors, which is in accordance with previous evidence (Andersen et al., 2012; Ayers et al., 2016; Dekel et al., 2017; Dikmen-Yildiz et al., 2018; Grekin & O'Hara, 2014; Maggioni et al., 2006; Malaju et al., 2022; Polacheck et al., 2012; Ross & McLean, 2006; Söderquist et al., 2006). By observing the distribution of these factors in the different trajectories groups we can see that the higher concentration of women having suffered from maltreatment in childhood, in adulthood or from mental disorders was in the non-resilient groups. This result could be explained by using both environmental and individual features. On the one hand, it is clear that having had a previous traumatizing event (e.g., maltreatment experiences) heightened the risk for mental disorders (i.e., represented in the present study by the post-traumatic stress disorder); on the other hand, it is also true that psychological predispositions in the individual (independently from previous events), may make them more likely to suffer from mental disorders, or, in this specific case, that a potentially traumatizing event can be perceived as traumatic, by resulting in PTSD symptoms (Andersen et al., 2012). While, about the perceived social support, even if the restrictions due to the pandemic have particularly affected possibility of social contact (Brooks et al., 2020a; Brooks et al., 2020c; Goldmann & Galea, 2014; Van Bavel et al., 2020), the perception of the support of significant ones still represents a significant PTSD's predictor (Andersen et al., 2012; Grekin & O'Hara, 2014). This result points out how having a positive social environment and support, despite the modality (i.e., mostly indirectly through electronic devices, or directly but without physical contact or facial expressions due to the obligation to use the mask) is a strong mechanism for stress buffering, which

protects maternal mental health (Malaju et al., 2022; Sumner, Wong, Schetter, Myers, & Rodriguez, 2012). Indeed, in the current research the higher mean for perceived social support is registered in the resilient PTSD group, while the lowest mean score characterizes the chronic group.

The last environmental dimension investigated as a risk factor for maternal perinatal PTSD is related to the Covid-19 pandemic, which can be analyzed through the direct objective exposure to the virus pre or postpartum, and the subjective distress and concerns related to being pregnant during a pandemic. Of these two aspects the only one that tends towards a differential significative effect on maternal PTSD is the subjective distress, which is particularly low in the resilient group compared to the other trajectories identified, and especially the chronic one. This result may be related to the fact that, also in this case, psychological predispositions in the individual are the key to interpret this outcome (Andersen et al., 2012). However, it is also necessary to mention that the direct objective exposure to the Covid-19 concerned a very little number of women in our total sample (3% of women contracted the virus during pregnancy, and 7% postnatally).

Considering the clinical-obstetric area we did not found a significant association on perinatal PTSD except for the fact of having not planned the pregnancy. This resulted significantly influent on maternal PTSD, in line with what reported in available literature related to pregnancy distress (Schoch-Ruppen et al., 2018; Staneva et al., 2016). This result could be explained by the fact that a similar lack of control or planning is already stressful, but it could be particularly relevant, so much to promote the PTSD symptoms onset, when another source of uncontrollability must be managed (i.e., the pandemic). In fact, the higher percentage of unplanned pregnancies is registered in the chronic group, which corresponds more or less twice that recorded in the other groups. Considering the parity status, we probably did not obtain any relevant result in accordance with the heterogeneous and contrasting evidence in literature about this theme and its weight on maternal mental health (Molgora & Accordini, 2020), so our data simply failed to contribute to this debate in the present research field. Then, we have to consider the fact that the delivery related factors (i.e., type of delivery and problems during delivery) show no significant associations with perinatal PTSD, even if existing data (mostly related specifically to PTSD after childbirth) support the opposite effect (Andersen et al., 2012; Ayers et al., 2016; Dekel et al., 2017; Grekin & O'Hara, 2014; Martínez-Vazquez et al.,

2021; Polacheck et al., 2012; Ross & McLean, 2006). However, this previous evidence can be considered as inconsistent, since the quality of studies is evaluated as moderate-to-low (Howard et al., 2014). Also, by observing the distribution data of the current study between the different PTSD trajectories groups, it is evident how, independently from the considered group, most of women had an assisted vaginal birth, which usually it is less associated with PTSD compared to cesarean childbirths (Mahmoodi et al., 2016). Furthermore, most of the women had no problems during delivery, which highlights that the majority of the women part of the current study's sample did not encountered the obstetric complications that may promote PTSD symptomatology (Andersen et al., 2012; Martínez-Vazquez et al., 2021; Polacheck et al., 2012; Ross & McLean, 2006).

### 2.4.3.    *Difficulties in parenting and in infants' emotional and behavioral regulation related to maternal perinatal PTSD*

The last aim of this research, which is only partially supported by our data analyses, considered the four groups of PTSD trajectories as predictors of outcomes related to parenting and child development. Different Multivariate Linear Regression Models were performed, and the results obtained were independent from socio-demographic features (age, SES, study qualification, mental disorders, maltreatment in childhood, and in adulthood), and experiences related to past and actual pregnancy (parity, and Covid-19 related pregnancy concerns). To our knowledge, no study before had tested these outcomes considering various PTSD trajectories over time, but only PTSD assessed at one time-point, and, precisely, measured during postpartum.

Starting with the parenting outcomes, we found a confirmation of the already existing evidence that highlights how maternal PTSD symptomatology affects the mothers' parenting behavior and perception of parenthood, as Van Ee et al. (2016) synthetized in their review. In the current research, belonging to a different trajectory group had a differential significant large effect, both considering parenting stress and parental burnout. In particular, higher PSI and PBA scores were registered in the chronic-PTSD group, which is in line with the fact that a chronic exposure to PTSD from pregnancy to 12 months postpartum has as result, one year after delivery, higher levels of

parenting stress, which represents a risk factor for developing parental burnout (Mikolajczak et al., 2018; Roskam et al., 2017).

Similarly, PTSD trajectories were tested in our statistical analysis as predictive factor for infant temperament assessed at 6 months, and behavioral problems investigated at 12 months. In these analyses focused on child development, unlike what reported for parenting outcomes, maternal PTSD trajectories over time show no statistically significant effect nor on infant emotion regulation, nor on behavior problems. In order to give some explanations of these non-significant outcomes, we can highlight some differences between the current research and the studies showing a significant relationship between maternal mental health and temperamental difficulties (Bosquet Enlow et al., 2011; Ionio & Di Blasio, 2014; Samuelson et al., 2017; Tees et al., 2010), such as in participants selection. In fact, Bosquet Enlow et al. (2011), recruited participants belonging to a primarily low-income, and ethnic/racial minority sample, which represent a small percentage of the present study's sample (i.e., only 4.2% of women referred a low income and 1.8% belonged to a different nationality from the Italian one). Also, other researchers have used different assessment procedures for children's temperament, like Ionio and Di Blasio (2014), who chose the Still-Face paradigm, and Tees et al. (2010), who, even if a parent-report method was respected, measured infant temperament with the Early Infant Temperament Questionnaire (EITQ) and the Toddler Temperament Questionnaire. Plus, considering these references, only in study conducted by Bosquet Enlow et al. (2011) the temperament was assessed, like in the present research, at six months. Meanwhile, regarding behavioral problems measured with CBCL, it is necessary to highlight that in the present study we used at 12 months an instrument that is structured to be submitted from 18 months, thus risking having obtained not reliable data. In line with this, most of the literature evidence in this area considered older children, with at least 18 months (Chemtob et al., 2010), and it considered also war veteran parents (Parsons et al., 1990; Rosenheck & Fontana, 1998), which represent a very specific cohort of parents with PTSD. Finally, it is somehow logic that in neither case of child development areas considered we obtained significant outcomes, seeing the mutual connection and influence between infant temperament and behavior (Caspi et al., 1995; Martins et al., 2021; Nigg, 2006).

To conclude, we could try to interpret the results on parenting and child development outcomes also by referring to the fact that these last-named results could be less biased than the parenting ones. That's because when a mother is asked to answer to questionnaires about her post-traumatic stress symptoms (e.g., "In the past month, how much were you bothered by irritable behavior, angry outbursts, or acting aggressively?") or her parenting stress and burnout (e.g., " I often feel like I can't handle situations very well", "I have zero energy to manage my children"), the investigated dimensions are somehow overlapped. Or anyways, they are more related than the fact of having PTSD symptoms and seeing and describing her baby with a difficult temperament and/or behavior, which could therefore suffer a lower degree of mutual influence (i.e., bias).

## *2.5. STRENGHTS AND LIMITATIONS OF THE STUDY*

The current research was administered through an online survey, which is the feature that represents the principal strengths and limitations of the study. In fact, the modality chosen allowed us to collect data in a specific period (i.e., the first assessment took place during the Covid-19 first Italian lockdown) when no other method would have been applicable, given the restrictions imposed (Favieri et al., 2021). Also, the study design might have made it possible to collect generalizable data, by reaching a large sample of women coming from different geographical areas on the Italian territory and belonging to diverse socio-economic backgrounds. However, our sample was not heterogeneous as expected, seen that it was made mostly by primiparous women living in North Italy (which represents the most affected area by the pandemic, especially in early stages), and in the third trimester of pregnancy. Additionally, data collected via online survey could be less accurate and precise, and therefore less generalizable, because of the absence of the researcher in real time to answer any doubt; of the exclusion of unwilling participants; and finally of the fact that participants could stop and continue later the survey.

Moreover, even if the longitudinal design represents a point of strength of the current research that had allowed us to study PTSD longitudinally, we should consider that it was assessed through the PCL-5 questionnaire, which is not a diagnostic tool, and is a self-report measure, where participants may not report their true opinions, either

because of social desirability, or because questions might be misinterpreted. Also, the first assessment (*t0*) was conducted at different stages of pregnancy, making the time elapsed between the first and second assessment different from case to case (from 6 to 14 months). Additionally, we did not investigate some characteristics that might have been relevant to correctly interpret the results obtained on PTSD, such as the actual traumatic event (i.e., pre-conception trauma, or pregnancy related trauma). This because different trauma could predict different developmental courses of symptomatology (Geller & Stasko, 2017), even if this specific aspect is poor specified also in previous literature (Grekin & O'Hara, 2014), and postpartum factors are less researched than antenatal or birth factors (Ayers & Ford, 2016).

Finally, the measures used to assess parenting and child development outcomes present some limitations: infant's results took in exam come from parent-report questionnaires, that, even if parental reports are reported to be very reliable also with laboratory and direct observations (Rothbart & Bates, 2006; Carey, 1982), may be however affected by the parent's psychological functioning (Rothbart & Beats, 2006; Sanson & Rothbart, 1995; Zentner & Bates, 2008),. Parenting measures, in their turn, are assessed at the same time-point (i.e., 12 months postpartum), and this represents a methodological choice which is in contrast with the fact that parental burnout usually arises from a chronic stress condition (Mikolajczak et al., 2018; Roskam et al., 2017). We could have therefore not detected these women not exposed long enough to high levels of parenting stress to develop parental burnout.

### 2.6. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Maternal mental health is a crucial and vulnerable aspect in perinatal period, which can affect maternal and infant outcomes, both during pregnancy and postpartum, and also in longer term (Davis & Sandman, 2010; Erickson et al., 2022; Glover et al., 2018; Lequertier, 2018; Stein et al., 2014; Young & Ayers, 2021). Perinatal PTSD in particular is one of the disorders where the research has recently focused (Moran Vozar et al., 2021; Onoye et al., 2013), highlighting its presence and its heterogeneous features and consequences.

The current research catches on the need to implement the knowledge to better sustain the mothers in this delicate phase, as well as to compensate for the lack of research in the perinatal PTSD field (Moran Vozar et al., 2021; Stevens et al., 2020). Indeed, our study aims to give a longitudinal description of the perinatal PTSD, which is a disorder that is not commonly included in the conversation regarding maternal mental health, even if it is a worldwide mental health problem that can affect individuals during pregnancy and has proper predictors and outcomes. The most outstanding result, in the specific environmental condition of the Covid-19 pandemic, is the prevalence rates, which showed levels of PTSD similar to those coming from pregnancies considered at high-risk, even if the sample was a community one. This conclusion comes with several implications: firstly, the higher prevalence of perinatal PTSD makes evident the need of a sensibilization of clinicians, followed by integrated and effective screening and psychoeducation (Moran Vozar et al., 2021). Secondly, by assimilating Covid-19 exposed pregnancies to HRPs, we must also consider, in order to provide a proper treatment, some specific features that literature has highlighted about this last-named group. In fact, higher psychological distress and more negative emotions related to the pregnancy and to the stress management are registered (Gray, 2006; Mccain, & Deatrick, 1994; Rodrigues, Zambaldi, Cantilino, & Sougey, 2016).

Finally, increasing awareness on potential direct and indirect effects that Covid-19 pandemic may have on perinatal mental health is essential to early identification of post-traumatic stress symptoms and to accede to early and adequate treatment plans (Brooks et al., 2020c; Caparros-Gonzalez, & Alderdice, 2020). In order to better understand perinatal PTSD, we longitudinally explored the different trajectories it may take, such as resilient and non-resilient patterns. This heterogeneity shows the relevance of multiple mental health assessments during the perinatal period in order to promote resilience in every observed pattern. Our data highlights also that these needed assessments should take also in account which conditions are associated with a higher risk for perinatal PTSD, paying special attention to pre-existing and concurrent vulnerabilities of the individuals (i.e., lack of social support, previous mental disorders and maltreatment experiences in childhood and in adulthood), specific features of the pregnancy (i.e., unplanned pregnancy), and, for the Covid-19 exposed pregnancies, some pandemic related stressors (i.e., Covid-19 related pregnancy concerns). The attention that

perinatal PTSD deserves is even more underlined by the association found between parenting stress and parental burnout and mothers who were vulnerable for PTSD, where the worst results were associated mostly with chronic PTSD. On the contrary, following contradictory evidence, our results on infant temperament and behavior did not show an association with the different trajectories of PTSD, but research to better examine the impact of these trajectories on child outcomes is needed.

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