IMPACT OF MATERNAL METHAMPHETAMINE ("TIK") USE ON THE COGNITIVE DEVELOPMENT AND SCHOOL READINESS OF CHILDREN IN EARLY CHILDHOOD DEVELOPMENT: A SYSTEMATIC REVIEW

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Full Thesis submitted in fulfilment of the requirements for the degree

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July 2023

Abstract

Methamphetamine (MA) is one of the most used synthetic simulants globally and is reportedly the second most prevalent illicit drug. The abuse of methamphetamine among pregnant women is a growing problem worldwide. Exposure to this drug affects children's prenatal and postnatal development, which manifests in the growing child during early childhood development (ECD). Therefore, the current study examined the impact of maternal methamphetamine ('tik') use on children's cognitive development and readiness for school. A systematic review study design was utilised in order to obtain the findings of the study. A systematic review is the reviewing of diverse and inter-related studies in order to provide an interpretive understanding of an issue and present a balanced and impartial summary. The present systematic review critically filtered and evaluated peer-reviewed, full-text studies in the English medium between the years 2010 to 2020 of available research relevant to this particular research question: "What is the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development?". The findings of the study found that maternal methamphetamine use has equally a direct and indirect effect on children, their cognitive development and their readiness for school during ECD. These effects include neuro-behavioural issues, an influence on neurodevelopment, cognitive deficit in childhood, delayed academic development, learning difficulties and reduced accuracy when performing tasks. Maternal methamphetamine (MM) use influences children's cognitive development, affecting children's school readiness, thus impacting adequate development during ECD and resulting in poor school performance. Given the findings, future research needs to focus on MM use and its association with school readiness and performance. It is recommended that future research on MM use on the cognitive development and school readiness of children ECD in the South African context is a need in order to develop culturally appropriate interventions.

Keywords

Maternal

Methamphetamine ("*tik*")

Cognitive development

Developmental difficulty

School readiness

Early childhood development

Systematic review

Bio-ecological Systems Theory

List of Acronyms

BEST - Bio-ecological Systems Theory

CASP - The Critical Appraisal Skill Program

ECD - Early Childhood Development

MA - Methamphetamine

MM - Maternal Methamphetamine

NSDUH - National Survey on Drug Use and Health

SACENDU - South African Community Epidemiology Network on Drug Use

Declaration Statement

I hereby declare that the dissertation, '*Impact of maternal methamphetamine ("tik") use on the cognitive development and school readiness of children in early childhood development: A systematic review*' is my own work and that all resources that were used or during the research study, are indicated by means of a complete reference and acknowledgement.

Full names: Abigail Willemse

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Date: 19 July 2023

Dedication

This dissertation is dedicated to all the children who has been impacted and affected by maternal methamphetamine use, who continue to suffer in silence both cognitively and academically. I write this thesis in advocacy for those children struggling through life with difficulty they had no choice in. This study is dedicated to all the mothers thinking about and those already using drugs during pregnancy, with the hope that change will take place. Below are parts (in order for the poem to relate to the study) of a poem called “my name is meth”, dedicated to the families, mothers and children affected by methamphetamine.

My Name is Meth

I destroy homes, I tear families apart,

Take your children, and that’s just the start,

I’m more costly than diamonds, more precious than gold.

The sorrow I bring is a sight to behold.

If you need me, remember I’m easily found,

I live all around you, and maybe next door.

My power is awesome, try me you’ll see,

I take kids from parents, and parents from kids.

I have many names, but there’s one you know best,

I’m sure you’ve heard of me; my name is crystal meth.

[This was written by a young Indian girl who was in jail for drug charges and was addicted to meth. **Drug-free Australia: Promoting illicit Drug Prevention Initiative Nationally**]

Acknowledgements

I would like to start by acknowledging my Heavenly Father, who has given me the spiritual strength and mental sustenance to undertake this study and to persevere and complete my thesis. Without God's blessing, this achievement would not be possible. My warmest gratitude and appreciation are extended to the following individuals:

My mother, without your unfailing love, encouragement and support, I do not know where I would be – because it is only a mother that can love and give without expecting anything in return. I'm forever grateful to you.

My late grandfather, Mr Barron, your continuous encouraging words and your example of perseverance helped push me through difficult times. I wish you could have been here with me, and I hope I have made you proud.

A deep sense of gratitude to my supervisor, Professor Charlene J. Erasmus, no words of thanks can sum up how thankful I am to have had you has a supervisor and mentor. Your honest and constructive feedback has guided me through the bulk of the work – your kind and rigorous insight on this thesis motivated me to perform to the best of my ability. I remain thankful to you for embarking on this journey with me.

Thank you to Professor Edna G. Rich, for the opportunities and for working with me.

For the financial sponsor of my research, thank you to The National Research Foundation.

Lastly, I want to thank the university, the Centre for Interdisciplinary Studies of Children, Families and Society specifically, for granting me the opportunity to undertake this study and to all my family and friends who have remained supportive towards me throughout my academic journey.

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CHAPTER ONE

INTRODUCTION OF THE STUDY

1.1 Background and Introduction

Methamphetamine (MA), the second most illicit drug used worldwide (World Drug Report, 2017), "is a highly addictive synthetic psychostimulant that increase energy and feelings of euphoria, among other physiological effects" (Watt et al., 2014, p. 4). In South Africa, methamphetamine is known as '*tik*' due to the ticking sound produced when being smoked, and it is also the colloquial name for the drug (Howell, 2015; Peltzer et al., 2010). This extremely addictive drug use is the highest in the Western Cape (Dada et al., 2020). A reported 35-43% of the patients who seek treatment for drug abuse report methamphetamine as their primary drug (Warton et al., 2018a). Of these, 18% are men, and 12% are women using the methamphetamine ('*tik*') drug (Lion et al., 2017; Watt et al., 2014) in Cape Town, South Africa. Another study by Warton et al. (2018b) concluded that 8.1% of pregnant women used methamphetamine. The average annual methamphetamine use among men over the age of 18 years old was 8.7 per 1000 adults, whereas, among women, it was 4.7 per 1000 adults (Daiwile et al., 2022). Around 27 million people worldwide, 0.5 per cent of the adult population, have used methamphetamine in the past year (World Drug Report, 2020). However, knowledge on maternal methamphetamine use is limited because studies on this issue have used small research samples (National Institute on Drug Abuse, 2019). Methamphetamine remains the most frequently reported primary drug used in Western Cape. Methamphetamine usage increased from 27% in 2018 to 44% in 2020, respectively (South African Community Epidemiology Network on Drug Use (SACENDU) (Dada et al., 2020). In South Africa, methamphetamine use has risen sharply, with an increasing number of newborn babies being delivered daily with known maternal methamphetamine use during pregnancy (Van Dyk et al.,

2014). In South Africa, it is reported that 1.6% of expecting mothers use drugs (Brink et al., 2022). Over the years, there has been a dramatic increase in women who use methamphetamine during pregnancy (Sebastiani et al., 2018). The number of women using and abusing methamphetamine increased over the past decades, and the effects on neonates are not completely known (Moghaddam et al., 2021). It is found that 10% of pregnant mothers in the Western Cape use methamphetamines, called maternal methamphetamine (Prinsloo & Ovens, 2015), and approximately 5.2% of pregnant women used methamphetamine at some during their pregnancy worldwide (Baker et al., 2022).

Brink et al. (2022) state that "substance abuse during pregnancy is on an increase worldwide and is a significant public health concern" (p. 526). Maternal methamphetamine (MM) use has various adverse developmental effects for children exposed to the drug while the mother is pregnant (Nguyen et al., 2010). It has pre and post-natal developmental effects on the child (Warton et al., 2018a). There are numerous effects on the child when prenatally exposed to methamphetamine, including small size, heart and brain abnormalities, and premature delivery (National Institute on Drug Abuse, 2019). Using substances during pregnancy can cause irreversible abnormalities such as poor growth, delayed motor development, and deficits in visual system development (Van Dyk et al., 2014). Prenatal (maternal) methamphetamine exposure affects the child's birth outcome, brain structure and neurodevelopment outcome (Zhang et al., 2021). Exposure to methamphetamine during pregnancy may lead to long-term effects such as the quality of life in perinatal and late childhood (Zhang et al., 2021). Children's cognitive developmental abnormalities are one of the effects of drug use during pregnancy. Cognitive development is the process concerned with the whole structure of knowledge and how one interacts and understands the environment (De Witt, 2016). Cognitive development may be delayed or negatively affected when exposed to harmful chemicals (i.e. maternal methamphetamine use). Cognitive developmental delays, such as cognitive functioning, have

a detrimental impact on children's learning abilities, which in turn could affect their development during early childhood (De Witt, 2016). As stated by Van Dyk et al. (2014), language delays, a delay in mathematics skills, autistic characteristics and other difficulties, as well as increased aggressive behaviour, have been among the specific developmental and behavioural difficulties identified in methamphetamine-exposed children.

Maternal methamphetamine (MM) exposure alters the structure and the functioning of the brain. The structural changes of prenatal methamphetamine exposure in children are associated with cognitive impairment in motor functioning, memory and attention (Roos et al., 2015). These alterations in the brain could lead to a delay in cognitive development in children exposed to MM, and developmental delays affect the functioning in school with the subsequent experiencing of learning difficulties resulting in poor performance (Roos et al., 2015). However, minimal research has been done to delineate specific developmental and behavioural deficits in preschool children exposed to prenatal maternal methamphetamine (Van Dyk et al., 2014). According to Gabrhelik et al. (2023), a "limited number of studies analyse the association between prenatal methamphetamine (MA) exposure and child's developmental outcomes" (p. 1). However, preschool and school-age children had subtle but noteworthy attention impairment and were more likely to have behavioural and cognitive issues in school connected to difficulties with self-control and executive functioning (National Institute on Drug Abuse, 2019). Therefore, it is paramount to understand the importance of early childhood development for children.

Early Childhood Development (ECD), "the process of emotional, cognitive, sensory, spiritual, moral, physical, social and communication development of children from birth to school going age" (Children's Act 38 of 2005, p. 94), prepares children for school and ensures that they are ready for mainstream schooling. ECD is a comprehensive approach to programmes and policies

for children from birth to seven years old, and the purpose is to protect the rights of children to develop their full physical, social, emotional and cognitive potential (Guidelines for Early Childhood Development Services, 2006). Preschool children exposed to methamphetamine prenatally experience detrimental effects on their cognitive processes, leading to diminished school performance, delayed verbal skills, and impaired memory. These factors can hinder learning abilities, resulting in poorer educational outcomes (Diaz et al., 2014). Hence, understanding the influence of maternal methamphetamine use on children's cognitive development will allow one to identify how it will affect their readiness for school during the ECD phase.

1.2 Theoretical Framework

The bio-ecological system of Bronfenbrenner, which look at individuals in their environment, is the theoretical underpinning of this study. Bronfenbrenner (1989) states that "people both produces and are products of their own development" (Louw & Louw, 2014, p. 62). Bronfenbrenner is further of the opinion that one's well-being is influenced by the social context and the function and quality of relationships one has with others, such as family, neighbours and institutional systems (Boon et al., 2012). The ecological perspective is relevant for this study as it looks at the holistic perspective of the child on the person, family and community levels. Bronfenbrenner (1989) structures the individual's environment into five levels; the microsystem, mesosystem, ecosystem, macrosystem and chronosystem (Boon et al., 2012). The microsystem focuses on people and objects in an immediate individual environment who directly participates with the child, e.g. parents and siblings – this level will focus on the mother using drugs and the unborn child. The mesosystem represents the relationship among the social groups' friends, schools, or the workplace, where different microsystems interact with each other. This level focuses on the ECD teachers and the learners. The ecosystem represents the environmental elements that profoundly influence a child's development, even

though that child is not directly involved with them (Louw & Louw, 2014). Substance use, abuse, violence, and recreation centres within the child's environment illustrate the ecosystem. The macrosystem characterises the cultural fabric of the individual society, represented through ECD policies and societal views and customs. Lastly, the chronosystem relates to environmental events that occur throughout a child's life – such as growing up with a mother that used methamphetamine during her pregnancy.

1.3 Problem Statement

Maternal methamphetamine (*tik)* use among pregnant women is a growing problem in South Africa (Van Dyk et al., 2014). Children exposed to maternal methamphetamine use during pregnancy display specific developmental delays and impairments (Zhang et al., 2021). The use of maternal methamphetamine during pregnancy affects embryo development as it can easily cross the placenta barrier – therefore, the exposure affects neurodevelopment, structural brain changes and ultimately, cognitive outcomes (Zhang et al., 2021). Children exposed to methamphetamine thus perform poorly in cognitive activities. The purpose of the study was to explore and foster an adequate understanding of how maternal methamphetamine use influences cognitive development, school readiness of children and their educational performance during early childhood development. Such knowledge may aid in developing new and improved research and intervention strategies that cater to the needs of these children developing differently than those not exposed to maternal methamphetamine.

1.4 Research Question

What is the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development?

1.5 Aim and Objectives

1.5.1 Aim

The aim of this study was to examine the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development.

1.5.2 Objectives of the study

The objectives of the present research study were:

- To identify the effects of maternal methamphetamine (*tik*) use on the cognitive development of children in ECD.
- To identify the effects of maternal methamphetamine (*tik*) use on the school readiness of children in ECD.
- To appraise the methodological rigour of studies exploring the impact of maternal methamphetamine (*tik*) use on school readiness of children in ECD.

1.6 Research Methodology

The study used a systematic review methodology, which is a scientific way of a mixture of information by primarily searching and objectively analysing the studies dealing with a given issue (Vergnes et al., 2010). Hemingway and Brereton (2009) describe a systematic review as the reviewing of diverse and inter-related studies in order to provide an interpretive understanding of an issue and present a balanced and impartial summary of the findings. Systematic reviews attempt to "bring the same level of rigour to reviewing research evidence as should be used in producing that research evidence in the first place" (Hemingway & Brereton, 2009, p. 1). The present systematic review critically filtered and evaluated peer-reviewed, full-text studies in the English medium between the years 2010 to 2020 and includes studies of qualitative, quantitative and mixed methodologies. These studies were retrieved from databases available in the library of the University of Western Cape, which report on what is

the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development.

The study's assessment strategy was shared and allocated in a four-step process: Identification, Screening, Eligibility, and Inclusion. In addition, a meta-synthesis, an interpretation of the interpretations of primary data by the original authors of the fundamental studies (Zimmer, 2006), was used to combine findings extracted from the included studies. A detailed explanation of the systematic procedure and data collection is discussed in Chapter 4.

The results of the systematic review are presented in chapter 5.

1.7 Significance of Study

Considering the rise in maternal methamphetamine use by pregnant mothers in society today, it is important to understand the impact it has on our children. There is a limited amount of information available, in the South African context, regarding the effect and impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood in order to guide our knowledge for future research fully. Prinsloo and Ovens (2015) state that substance abuse by mothers during pregnancy is under-researched. Therefore, studies should be conducted on children born to drug-dependent mothers to ascertain the actual harm done initially and in the long term. The current study provides needed information to address the identified issue in a systematic and rigorous manner. The information provides knowledge that contributes to the welfare of children affected by maternal methamphetamine, which can be used to develop and restructure policies and programmes to cater to the needs of the children in ECD.

1.8 Definitions of Terms and Concepts

Maternal: relating to a mother, especially during pregnancy or shortly after childbirth (Oxford Dictionary, 2017).

Methamphetamine: also known as **"tik",** is an extremely addictive stimulant drug in the form of a white, odourless, bitter-tasting crystalline powder (National Institute on Drug Abuse, 2014).

Cognitive Development: the process concerned with the whole structure of knowledge and how one interacts and understands the environment (De Witt, 2016).

Developmental difficulty/ies: includes condition(s) that place a child at risk of sub-optimal development or that cause a child to have a developmental delay, disorder or disability (Integrated Policy on ECD, 2015).

School readiness: refers to the skills needed to prepare a child for formal instruction from a specific situation, such as formal education (De Witt, 2016).

Early Childhood Development: this is the period of human development from birth until the year before a child enters formal school (Integrated Policy on ECD, 2015).

Systematic Review: this is a way of summarising research evidence based on peer-reviewed protocol (Hemingway & Brereton, 2009).

Bio-ecological system theory: suggests that human development is a transactional process in which an individual's development is influenced by his/her interactions with various aspects and spheres of their environment (Patel, 2011).

1.9 Structure of the Thesis

Chapter One: an introduction to the study provides the context and background of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development in South Africa. It presents an overview of the importance and rationale for the study and provides the research question, aim and objectives of the study. The theory

underpinning this study, the research method executed and the significance of the study are briefly presented in this chapter.

Chapter Two: an in-depth discussion of the theoretical framework that underpins this study is presented here. This bio-ecological systems theory of Bronfenbrenner guided this study.

Chapter Three: introduces a literature review of relevant and current literature that focuses on maternal methamphetamine, cognitive development, school readiness, early childhood development, developmental delays and school performance.

Chapter Four: provides a detailed description of the methodology employed to conduct the study. It presents the systematic steps undertaken to assess the relationship between maternal methamphetamine and children's cognitive development and school readiness in early childhood development. The systematic procedure and data collection are discussed. The content of the methodology, such as the aims, objectives, research design, review questions, method of review, retrieval strategy, levels of review, data analysis and ethical consideration, are discussed.

Chapter Five: represents a detailed and descriptive interpretation of the results of the systematic review in the form of a meta-synthesis. The chapter comprises the process of results and the data extraction, which presents the data collected at different levels of review of those studies included in the research.

Chapter Six: consist of a discussion of the data analysis and a theory explanation of the meta-synthesis. The discussion is presented in three separate stages, namely, reciprocal translations, refutational synthesis and line of argument, which will provide a complete understanding of the given study's findings.

Chapter Seven: comprise the conclusion of the study, which includes an executive summary, the significance of the study, the limitations of the research study and the recommendations for future research.

1.10 Chapter summary

This chapter gives insight into the background and introduction to the current research question. It also provides a brief look at the theoretical framework of the current study, the problem statement, the aim and objective, the research methodology and the significance of the current study. Finally, the chapter provides the reader with definitions of terms and concepts and the structure of the thesis.

CHAPTER TWO

THEORETICAL FRAMEWORK

2.1 Introduction

This chapter provides the theoretical underpinning for the study and the work of Bronfenbrenner's Bio-ecological Systems Theory which is the framework that guided the understanding and thinking on maternal methamphetamine use and the effect it has on the cognitive development of children in early childhood development. Bronfenbrenner's theory focuses on human development from an ecological perspective, in which an individual's experience is nested within interconnected systems. This chapter discusses how the main concepts of the theory relate to the current study.

2.2 Origin of the Bio-ecological Systems Theory

Bronfenbrenner's bio-ecological systems theory (BEST) of human development is one of the most widely known theoretical frameworks across various disciplines and fields of practice in social sciences (Velez-Agosto et al., 2017). Human development is the process through which the growing person acquires a more extended and valid conception of the ecological environment, becomes motivated, and engages in activities in the environment (Leonard, 2011). Within the bio-ecological theory, development is defined as the phenomenon of continuity and change in the bio-psychological characteristics of human beings, both as individuals and as groups (Bronfenbrenner & Morris, 2006). Bronfenbrenner (1989) states that "people both produces and are products of their own development" (Louw & Louw, 2014, p. 29). Bronfenbrenner further states that one's well-being is influenced by the social context and the function and quality of relationships with others, such as family, neighbours and institutional systems (Boon et al., 2012). The BEST addresses various organisational

determinants of health and the political and cultural dimensions that influence an individual's well-being (Bone, 2015).

Bronfenbrenner has been described as a pioneer who has made outstanding contributions and influenced the work and writing of many scholars in studying the ecology of human development (Derksen, 2010). Bronfenbrenner's bio-ecology systems theory was introduced in its original form as the Ecological Systems theory in late 1970 (Joly, 2016). From the mid-1990s to the 2000s, Bronfenbrenner's theory highlights a metamorphosis in his ecological systems theory to a bio-ecological theory of human development (Ashiabi & O'Neal, 2015) in a way that stays true to the original concept. The ecological theory gave prominence to place to the environment and divided an individual's environment into nested and interrelated systems (Ashiabi & O'Neal, 2015). With the refinement and revision of the theory to the bio-ecological model, more concern was given to differentiating between the concept of environment and the person (Ashiabi & O'Neal, 2015), which was developed in response to the restrictive scope of this field at the time (Joly, 2015). The bio-ecological theory considers both physical and social environments important for the creation of health (Bone, 2015).

Bronfenbrenner viewed development as emerging from the interaction of individual and context, and the reformulation of his original ideas came about as he came to stress the role played by individuals, the impact of time and most important of all, proximal processes (Rosa & Tudge, 2013). Bronfenbrenner's theory has four major components: process, person, context and time (Krishnan, 2010). The *proximal processes* are the centre of the BEST and are viewed as the driving forces of human development as it emphasises the role played by the person in his/her development (Rosa & Tudge, 2013). The proximal-or near-processes involve a variety of connections between the child and the immediate surroundings responsible for the child's development and well-being (Krishnan, 2010). For example, the *person* represents the

influence of the family, caregiver and peers that are most likely to influence the characteristics and development of the child (Rosa & Tudge, 2013). The *context* refers to the multiple venues modifying the proximal process, which includes the child's environment that is in contact interaction with the child (Krishnan, 2010). According to Bronfenbrenner (1989), the *context* is structured in the individual's environment into five levels: the microsystem, mesosystem, exosystem, macrosystem and chronosystem (Boon et al., 2012), to provide a holistic perspective to the theory. Figure 2.1 presents these different layers and a detailed discussion of each system's influence below:

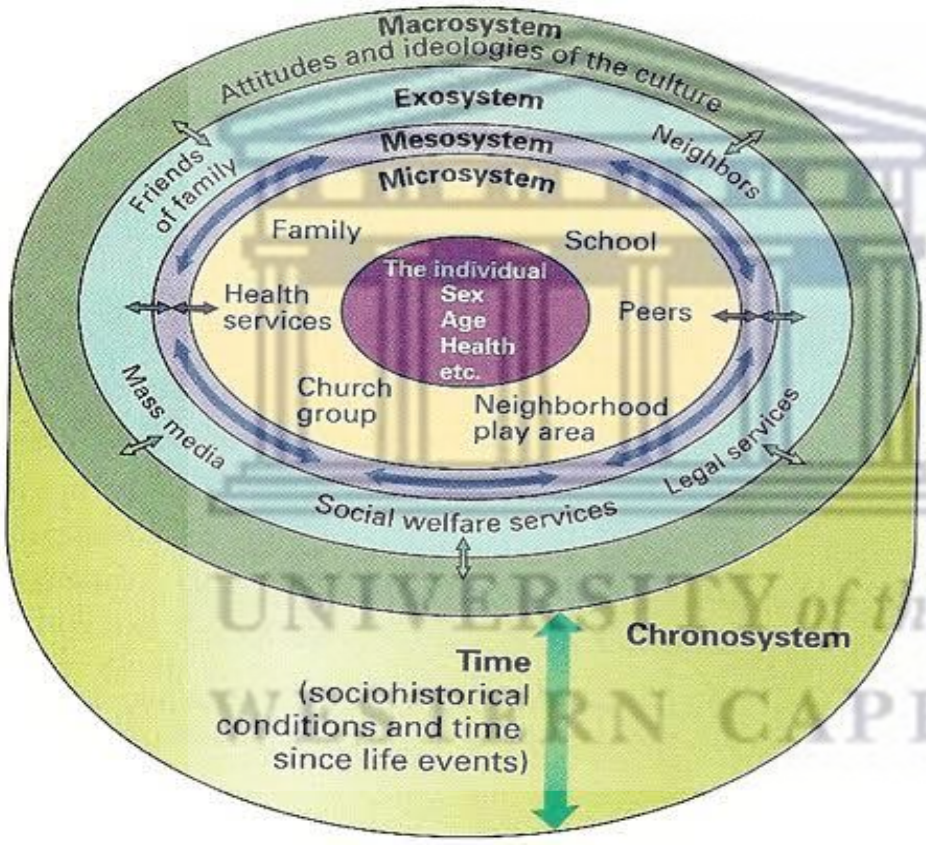

Figure 2.1: Bronfenbrenner's theory (Source: Santrock, 2008, p.33)

2.3 Description of the Bio-ecological Systems Theory

2.3.1 Microsystem

The microsystem is defined as a pattern of activities, roles and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics (Bone, 2015). The microsystem represents the people close to a child, such as the parents and siblings, who strongly influence the child's development (Louw & Louw, 2014). This system is considered the most intimate learning setting. It offers the child a reference point for the world (Swick & Williams, 2006). This system directly impacts the child's growth and development, which indicates the significance of this subsystem. The microsystem focuses on people and objects in an individual's immediate environment who directly participates with the child, e.g. parents and siblings – this level will focus on the mother using drugs and the influence on the unborn child. The microsystem level is seen as the most immediate and earliest influence on the child (Krishnan, 2010) and can help influence healthy personality development (Swick & Williams, 2006). This level can look at the influence and relationship maternal methamphetamine has on the unborn child, as the mother has direct contact with the child before and after the child's birth. Bronfenbrenner called this relationship bi-directional since the child's family (in this case, the mother during pregnancy) can influence the behaviour and development of the child (Krishnan, 2010).

2.3.2 Mesosystem

The mesosystem refers to a linkage or overlap between settings in which the individual is a participant (McLaren & Hawe, 2005). This level is the second immediate level in the child's development (Krishnan, 2010). It also contains the interrelations among two or more settings where the child actively participates, e.g., the child's family and/or the day centre (Bone, 2015). The mesosystem includes interactions with family and peer relationships (Eleuteri & Arduino 2014). Intrapersonal relationship development is therefore important during this subsystem.

The mesosystem is similar to the microsystem, the main difference being that the activities and interpersonal roles occur across settings rather than within a single microsystem (Rosa & Tudge, 2013). The mesosystem represents what happens in one microsystem and likely influences other systems. For example, the mesosystem represents the relationship among the social groups' friends, schools, or the workplace, where different microsystems interact with each other. This level focuses on the ECD teachers and the learners. For example, what happens at the child's home (microsystem) can influence what happens on the playground and the child's classroom development. In this subsystem, during this stage, it becomes more prominent to start to observe developmental and cognitive milestones by the child interacting with the child's peers. Also, the ECD teachers are able to ascertain whether a child is struggling cognitively or not.

2.3.3 Exosystem

The exosystem refers to the setting that does not involve the child as an active participant but in which the child is affected by what happens in the setting containing the child (Bone, 2015). This system represents contexts the child experiences indirectly, yet they directly impact the child (Swick & Williams, 2006). Whereas Louw and Louw (2014) refer to the exosystem as social settings that a person may not experience first-hand but still influence the development, thus applying a unidirectional influence that directly/indirectly impacts the developing person (Johnson, 2008). The system contains micro- and meso systems, which influence the child's development and the well-being of those who encounter the child (Krishnan, 2010). The mother's work environment is part of the child's exosystem, as the influence of the exosystem is a second-hand influence. The exosystem is the environmental elements that have a profound influence on a child's development, even though that child is not directly involved (Louw & Louw, 2014) – this level looks at the drug abuse, violence and recreation centres within the child's environment in which the child's development might be influence by this level. For

example, if a child lives in an environment filled with violence and drug abuse, it impacts their ability to develop to their full potential. Therefore, the parents or caregivers might not recognise the true extend of the impact of maternal methamphetamine on the child.

2.3.4 Macrosystem

The broader environmental context is the macrosystem which refers to the overall patterns of ideology and organisation that characterise a given society or social group and may be used to describe the culture or social context of various societal groups such as social class or religious affiliation (McLaren & Hawe, 2005). It is often considered the "social blueprint" of a given culture, lifestyle or customs (Johnson, 2008). The macrosystem is the subculture and culture in which the micro-, meso- and exosystems are embedded (Louw & Louw, 2014). Children's culture influences their development, and each child's development is within a unique macrosystem. The macrosystem represents the cultural fabric of the individual society – this level focuses on ECD policies, views and customs. For example, during this level, one would look at the school's policy on special needs if children were to be observed to have developmental delays, which have a macrosystem influence on the child and the way in which they develop. Due to the limited information on the impact of maternal methamphetamine, it is difficult to recognise children that might struggle in school due to prenatal methamphetamine exposure or a child that is developmentally delayed. Therefore, it is difficult to develop policies that can assist maternal methamphetamine-exposed children in order to be adequately prepared for school readiness.

2.3.5 Chronosystem

The chronosystem is also known as *time,* the last of the four major components of Bronfenbrenner's theory. Time (chronosystem) is "the individuals own developmental life course is seen as embedded in self and powerfully shaped conditions and events occurring during the historical period through which a person lives" (Rosa & Tudge, 2013, p. 254). The

system and its relation to the other levels were developed only later to the model and are the evolution of the development of the external system in time (Eleuteri & Arduino, 2014). The chronosystem represents a time-based dimension that influences the operation of all levels of the ecological systems (Johnson, 2008). It is a description of the stream of developments of the specific external systems. The chronosystem can refer to both short- and long-term time dimensions of individuals over the course of a lifespan (Johnson, 2008). For example, the chronosystem for a child in school can be represented by the day-to-day and year-to-year development of the child. The chronosystem relates to environmental events that occur throughout a child's life – such as growing up with a mother dependent on drugs and/or suffering from a learning disability. As this level looks at the development of the child on a day-to-day and a year-to-year basis, the day-to-day or year-to-year development will inevitably affect the child's cognitive development and ability to prepare for school adequately.

2.4 Critiques of the Bio-ecological Systems Theory

Many have come in favour of this theory and the benefit thereof. However, there have been equal critiques of this theory. Christensen (2016) suggests that the theory is discussed within a theoretical framework because the model needs to be further developed. The BEST maintains that individuals always develop within the context of their respective environment(s) (Swick & Williams, 2006). Paquette and Ryan (2001) believe that an individual needs to be seen for their condition while simultaneously incorporating the system into the individual (Christensen, 2016). Christensen (2016) goes further to explain that the theory virtually describes only the negative effects of how an individual will develop if exposed to adversity and travesty and is lacking to incorporate how it affects the development within their subsystems (e.g. societally and environmentally), and having an understanding of the changes and development of the theory continues to misrepresent the theory – therefore, lacking in understanding how to incorporate how it affects the development within their subsystems (Rosa & Tudge, 2013).

Moreover, Christensen (2016) states that it does not have a way to explain how individuals brought up in a negative environment survive and become successful. It also needs to look at a different way to conceptualise the interrelatedness of the various systems.

Furthermore, Velez-Agosto et al. (2017) state that the bio-ecological systems theory's position on culture can be challenged by major theoretical views such as Vygotsky's social-cultural theory, Thomas Weisner's ecocultural theory and Babara Rogoff's transformation of participation perspective. In a certain way, all of them propose, as Markus and Kitayama (2009) state, that culture is not separate from individuals; it is a product of human activity. Therefore, one cannot solely focus on one system but look at how each system affects the individual and their development. Velez-Agosto et al. (2017) argue that in Bronfenbrenner's model, culture is barely formally introduced and the complexities thereof, which questions if the theory looks at how culture affects the child's development. The BEST "raises questions about treating individuals and cultural processes as separate entities" implicitly (Rogoff, 2003, p. 12) rather than recognising that culture affects the developing person. Culture plays an important role in the developing person/child. Velez-Agosto et al. (2017), therefore, propose that culture has the role of operationalising microsystems and becoming part of the central processes of human development to understand the systems better.

2.5 Applicability of the Bio-ecological System Theory

The bio-ecological systems perspective is deemed relevant for this study as it looks at the holistic perspective of the child on the person, family and community levels. The theory provides a holistic approach and offers a broad contextual analysis model to examine health problems encountered by individuals and groups in relation to the ecological circumstances present in their day-to-day physical and social environments (Bone, 2015). The theory emphasises the role that each subsystem has on the child's development and how it will impact

the child's developmental stages to be ready for school. The theory helps in aiding to assess the cognitive development and school readiness of children in early childhood development, as the benefit of Bronfenbrenner's bio-ecological theory is that it strives to keep both the individual and the context in balance when assessing development in children (Slomp, 2012). The theory illustrates the interconnectedness of the family, environment, and social and cultural context to the child's development and functioning and how each level of the theory equally influences the child's development.

As the BEST occurs in overlapping systems, where one system affects another system (Jordahl & Lohman, 2009), each interchangeably affects the growing child's development. Therefore, if the individuals involved in the child's life have knowledge of the theory, it will help them to be involved in the child's life and to understand the multiple facets of the impact and effect of maternal methamphetamine pertaining to the child's development. One will be able to understand that each system contributes to the development of the child. Due to the complexity and multidirectional nature of interactions in the theory (Jordahl & Lohman, 2009), it allows a look at how different interaction with the child influences the child's development. Individuals develop in ways that reflect their interactions within respective environments and social contexts, which can positively affect the child's development (Swick & Williams, 2006). The BEST can be used to measure the influence of development on the child because their development can be influenced by the position within the model of Bronfenbrenner's ordering and can thus have a direct or indirect effect on the child's development (Boon et al., 2012). In addition, the direct or indirect effects it has on child development indicate the importance of the theory on the (cognitive) development of the child and how it may influence their school readiness and how it might influence their functioning at school. This theory thus helps to look at the child's development in a multi-dimensional way and at all the different ways in which the child's development is influenced and impacted.

2.6 Chapter summary

This chapter introduces the theoretical framework underpinning this study, which is the bio-ecological systems theory – developed by Urie Bronfenbrenner. The chapter commences by explaining the origin of the theory and how it developed and transitioned from the ecological systems theory to a bio-ecological systems theory of human development. This is followed by a full description of the various levels/environments of the bio-ecological systems theory, which consists of the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. Next, the critiques of the theory by fellow scholars critically look at the theory and discuss its shortcomings and recommendation for improvement. Finally, towards the end of the chapter relevance and applicability of the bio-ecological systems theory for the study are examined and discussed as to why the theory is deemed fit for the current study.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

This chapter provides insight into the impact of maternal methamphetamine use and its association with cognitive development and school readiness in early childhood development. The chapter explores the effect of maternal methamphetamine use on children by first looking at what maternal methamphetamine is, then how it is connected to the children's cognitive development and school readiness, following by examining the way in which it affects early childhood development, and lastly exploring the relationship between maternal methamphetamine use and school performance.

3.2 Maternal Methamphetamine (MM)

Addiction of all types remains a serious problem worldwide, and a number of factors play a role in addiction, such as environmental influences, stress and genetic disposition (Slamberova, 2019). Slamberova (2019) states that "addiction is not synonymous with drug use, instead is a compulsive, chronic use of a drug that continues despite the negative consequences" (p. 220). Methamphetamine (MA) is a highly addictive stimulant and the most potent member of the amphetamine group of synthetic drugs. In contrast, maternal methamphetamine (MM) is the use of the drug during pregnancy (Wouldes et al., 2004). Methamphetamine is a potent psychostimulant, exerting its effects primarily on the central nervous system (CNS) by altering the release and activity of dopamine and feelings of euphoria (Warton et al., 2018b), followed by a "crash" that causes sleeplessness, anxiety, and aggression resulting from paranoia (Messina et al., 2014). The use of methamphetamine among pregnant women has become a significant problem in today's society affecting the health of individuals. The prevalence of methamphetamine use in pregnancy has increased the reported incidence of maternal drug use

(O'Connor et al., 2020). Female drug use tends to start slightly later in adolescence or young adulthood. They are believed to use drugs to alleviate psychological distress and are more vulnerable to addiction than males (Taylor et al., 2016). The prevalence of substance abuse among pregnant women is said to have increased almost threefold over the last few years, with methamphetamine being the drug of choice (Wouldes et al., 2014). Methamphetamine is set to be the primary drug of abuse in 24% of all substance users under the age of 20 years, and it was found that 92% of pregnant women were using methamphetamine (Kwiatkowski et al., 2018). Methamphetamine is among the most popular 'hard' drug used by expecting mothers and ranked among the most often used illicit drug – 40% used it during their pregnancy (Alsanie et al., 2023).

Consequently, females using drugs are more vulnerable to addiction, which might make it difficult for them to stop using when pregnant (Taylor et al., 2016). The reason for this is due to under-reporting in pregnancy and too late presentations for antenatal care (O'Connor et al., 2020). It can be noted that substance use (e.g. methamphetamine) harms both mother and child. Therefore, mothers who use substances are often limited in their capacity to effectively cater to their children's needs (Andrews et al., 2018). Their limited capacity to cater to their children's needs are due to the fact that parent who uses substances have higher stress levels and have a more critical attitude toward their children (Egan et al., 2020). Hence, maternal drug-dependency has far-reaching implications for the mother and her children (Taylor et al., 2016). The implications that drug-dependency has on the mother are aggressive, paranoid psychosis, cognitive impairments, emotional deficits and structural brain changes and the possibility of deep-brain strokes (Madide et al., 2012). For the child, prenatal effects include; adversely affecting the growth and development of the foetus and may place the infant at risk for a range of physical and neurodevelopmental problems and poor brain growth, which might be associated with significant functional impairment in the neonate (Madide et al., 2012;

O'Connor et al., 2020). Methamphetamine among pregnant women continues to be a persistent problem, resulting in children demonstrating serious behavioural problems, poor psychosocial well-being and lower academic achievements (Eze et al., 2016). Methamphetamine exposure affects newborns' prenatal and postnatal development (Viteri et al., 2015), with subsequent consequences on the children's cognitive development and school readiness. This leads to significant medical and cognitive impairment in the unborn foetus, which reflects the relationship between maternal methamphetamine use and neonatal outcomes (Prinsloo & Ovens, 2015). The effects of MM use after birth are that many infants show delays in movement, learning/memory, visual and motor skills and language difficulties. Hence, as they grow older, these children can develop psychological and behavioural problems (Egan et al., 2020). Therefore, delayed development can still be evident in preschool and early years (Slamberova, 2019).

3.3 Children in Early Childhood Development

The World Health Organisation (WHO) states that early childhood development (ECD) is considered to be the most important phase in life, which determines the well-being, learning, quality of health, and behaviour across the life span (WHO, 2014). ECD has been scientifically proven that it is a very sensitive period for brain development (Nurturing Care for Early Childhood Development, Report, 2018). ECD provides a strong foundation for learning and development before children enter school. In South Africa, ECD is defined as "an umbrella term that applies to the processes by which children from birth to at least nine years grow and thrive, physically, mentally, emotionally, spiritually, morally and socially" (White Paper on Early Childhood Development Education, 2001, p. 5). Early Childhood Development is vital in ensuring children are able to reach their full potential (Nurturing Care for Early Childhood Development, Report, 2018) and have the ability to reach their different developmental

milestones. Therefore, maternal methamphetamine (MM) children exposed to the drug may impact their ability to reach their full potential.

The use of methamphetamine has become endemic over the past decade, confirming a proliferation in the figure of children manifesting learning and behaviour problems (Prinsloo & Ovens, 2015). Children exposed to MM demonstrated high levels of aggression and behavioural problems, poorer psychosocial well-being and lower academic achievement (Eze et al., 2016). An optimal pre- and postnatal environment supports the child's physical, emotional, social and cognitive development (Nurturing Care for Early Childhood Development Report, 2018). Parents play a critical role in their child's development. Therefore there is a need for parents to have knowledge of this (the effect of methamphetamine use during pregnancy) and to be well supported (with resources on where and how to receive treatment for drug abuse) to be able to get help to be drug-free (O'Connor et al., 2020). In order to achieve this collaboration between the mother, hospitals and ECD centres, early intervention would be beneficial.

A study done by Addiction Intervention (2010) states that primary school learners display behavioural and learning problems due to drug exposure in their formative years (World Drug Report, 2017). This study further states that it makes school readiness difficult for children due to their exposure to MM use. MM-exposed children significantly decreased Full Scale Intelligence Quotient (FSIQ) and poorer attention (Moghaddam et al., 2021). Learning difficulties were attributed to apparent deficits in attention, memory and motivation, which further indicated children's difficulty in early childhood development in preparing children for school readiness (Kwiatkowski et al., 2018). Lack of school readiness may put the child at a disadvantage in the classroom environment (Kwiatkowski et al., 2018), thus setting the stage for poor academic performance and achievement.

3.4 Cognitive Development and School Readiness

Exposure to methamphetamine may have a major influence on cognitive performance in school. There is a lack of research on the effects of MM on cognitive development concerning school readiness. However, more research is focussing on the effects of MM use on the functioning of children in terms of their physical and cognitive development and the influence it has on their later behaviour during the school-going year (Prinsloo & Ovens, 2015). Moreover, a limited number of studies analysed the association between prenatal (maternal) methamphetamine exposure and child developmental outcomes beyond the perinatal stage (Gabrhelik et al., 2023). The limited available studies are due to many confounding factors such as other drug use, low social environment and lack of prenatal care (Maranella et al., 2022). Methamphetamine is one of the worse drugs, and studies have suggested that methamphetamine use is more damaging to the foetus than alcohol abuse by pregnant mothers (Prinsloo & Ovens, 2015). It is suggested that the concentration of the drug in the foetus is calculated in the mother's body, as the drug can easily cross the blood-brain and placental barrier (Slamberova, 2019). Maternal methamphetamine exposure in children can lead to various brain development and functioning delays and underdevelopment, affecting the child's cognitive function. Heavy prenatal methamphetamine exposure is associated with attention problems, which increase the risk for attention deficit hyperactivity disorder (ADHA), making it difficult for children to learn when undiagnosed (Eze et al., 2016). Wouldes et al. (2014) explain that children exposed to MM have early and ongoing deficits in neurodevelopment. It is suggested that these children have motor and learning impairments.

Prenatal methamphetamine exposure is described to cause neurobehavioral effects and long-term motor and cognitive delays (Maya-Enero et al., 2018). Maternal methamphetamine exposure can be linked to a variety of brain deficits. Cognitive tests done with children exposed to MM indicate that the children received a low IQ score (Wouldes et al., 2014) and

experienced a wide range of cognitive impairments, including executive functions, working memory and social cognition (Moghaddam et al., 2021). Maternal methamphetamine is related to long-term, negative changes to the structure of the brain, influencing cognitive and behavioural problems, thus affecting the structure and the functioning of the brain (Prinsloo & Ovens, 2015), which all affect the school readiness of the developing child. Moghaddam et al. (2021) state that "MA-exposed children presented decreased cognitive performance due to toxicity of MA during brain development (p. 2746)

Hutchinson et al. (2017) have identified characteristics of children affected by prenatal substance exposure - neonates prenatally exposed to substance use may show greater excitability and irritability, low or high muscle tone, automatic and central nervous system abnormalities and require more parent handling to settle. A study by Roos et al. (2015) suggests that children exposed to MM are associated with impaired cognitive functioning and general cognitive ability, including executive functioning. This impaired cognitive functioning plays a role in the children's school readiness. Children exposed to MM use also face behavioural problems, making it difficult to concentrate in class and causing a delay in motor development, which is important for school readiness (Eze et al., 2016). At age 6-7, children in South Africa enter formal schooling; therefore, children affected by MM use may exhibit accentuated structural abnormalities, which could be associated with learning difficulties (Roos et al., 2015). Children exposed to methamphetamine in the womb also present an abnormal volume increase in the brain region, which deals with control and conflict resolution (Prinsloo & Ovens, 2015). In addition, the children can have, when exposed, a reduced attention span and learning difficulties, which makes it difficult for them to retain information (Slamberova, 2019). Children's cognitive milestones and development influence school readiness, affecting their development during the ECD phase to be ready for mainstream school.

3.5 Maternal Methamphetamine and School Performance

Exposure to MM alters children's cognitive and neuropsychological brain development, which therefore affects children's school readiness and school performance. Maternal methamphetamine increases the difficulty in certain regions of the child's brain (Maya-Enero et al., 2018), therefore, having difficulty leaning or learning at a slower pace than non-exposed children. Brain development is important for children's adequate functioning in school; poor brain functioning can result in poor school performance. A healthy brain function is important as it helps children learn important educational aspects, such as colour, numbers and counting, during the early childhood development phase. In addition, brain functioning plays a role in the developing child's mental health. Slower mental health and sensorimotor development impact the child's school performance (Slamberova, 2019). Preschool MA-exposed children have shown poorer performances on visual-motor integration tasks, decreased scores on sustained attention, and delayed verbal memory (Moghaddam et al., 2021).

Inadequate mental health development relates to how children adapt to certain situations and interact and participate with their peers. Since prenatal exposure to methamphetamine affects the motor functioning of children, it results in children being unable to learn and demonstrate skills (relating to their motor patterns) required for school development. Pre-school and school-age children have cognitive issues in school related to difficulties in self-control and executive functioning (National Institution on Drug Abuse, 2019). Children exposed to prenatal methamphetamine adapt poorly to environments, which causes social inadaptability in relation to the child's school performance/readiness. This, therefore, indicates that MM use influences children's school performance. Understanding the impact of MM on children and the underlying mechanism is crucial for early detection and postpartum treatment for high-risk children (Li et al., 2021). Thus, early reporting of MM use by parents and ECD educators will

make early intervention possible to allow children to perform at their full potential for school readiness.

3.6 Chapter Summary

The literature review has indicated that methamphetamine has become a growing problem among pregnant women worldwide, especially in South Africa. Maternal methamphetamine influences the cognitive development of children. Using methamphetamine during pregnancy has been shown to impact children's (exposed to maternal methamphetamine) cognitive functioning, which in turn affects the child's school readiness. Therefore, if children's development is affected during the prenatal stage, it will influence the developing child's school performance.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

This chapter outlines the systematic steps to assess the impact of maternal methamphetamine ("tik") use on children's cognitive development and school readiness in early childhood development. The chapter provides a comprehensive account of the methodological procedures used during the execution of the current study and is presented in a descriptive manner. This chapter consists of various subsections: aim, objectives, review question, research methodology, method of review, search strategy, levels of review, data extraction, data analysis and ethical consideration. Each subsection plays an important part in the methodological process of obtaining data from which conclusions may be drawn.

4.2 Aim and Objectives

4.2.1 Aim

The aim of the study was to examine the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development.

4.2.2 Objectives

The objectives of the study were:

- To identify the effects of maternal methamphetamine (*tik*) use on the cognitive development of children in ECD
- To identify the effects of maternal methamphetamine (*tik*) use on the school readiness of children in ECD
- To appraise the methodological rigour of studies exploring the impact of maternal methamphetamine (*tik*) use on school readiness of children in ECD.

4.3 Review Question

As presented in Chapter 1, the research question that this study sets out to answer is: *What is the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development?* The PEO model was used to develop the research question, and the PEO acronym stands for **P**opulation, **E**xposure and **O**utcome (Pollock & Berge, 2018). How each factor fits into the research question is as follows; P: children (in early development), E: exposure to maternal methamphetamine, and O: cognitive development and school readiness.

4.4 Research methodology

A systematic review methodology was used to execute the study, which is a scientific way of a mixture of information by primarily searching out and objectively analysing the studies dealing with a given issue (Vergnes et al., 2010). A systematic review reviews diverse and interrelated studies to provide an interpretive understanding of an issue and present a balanced and impartial summary (Hemingway & Brereton, 2009). According to the Cochrane Handbook, a systematic review "uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made" (Munn et al., 2018, p. 2). It aims to look at other studies to obtain the gaps in the study and critically look at how research can be improved. Systematic reviews attempt to "bring the same level of rigour to reviewing research evidence as should be used in producing that research evidence in the first place" (Hemingway & Brereton, 2009, p. 1). Petticrew and Roberts (2008) and Higgins and Green (2011) deem a systematic review appropriate as it is a means of filtration through a systematic process of identifying, evaluating and interpreting all available research relevant to this particular research question: "*What is the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development?*"

4.4.1 Inclusion criteria

When developing the inclusion criteria, locating and retrieving relevant literature for the review is important. A systematic review that does not include any relevant studies can be referred to as an "empty review", which refers to a study of little value to research (Pollock & Berge, 2018). Therefore, the inclusion criteria used to determine whether a study should be included in the review to examine the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development were:

Time period of review: The study only included research published during the ten years ranging from 2010 – 2020, as it covers the most recent literature and developments. Prior to 2010, few studies focused on the relationship between the neonatal (newborn) and maternal methamphetamine outcome. Thus, this research is needed to illiterate the negative effects of substance use on the developing foetus (Prinsloo & Ovens, 2015).

Participants: The review considered studies that included children between the ages 0-6 born of maternal methamphetamine (*tik*) use. The use of methamphetamine during pregnancy puts the unborn child at risk for later developmental, behavioural, and neurological problems (Kwiatkowski et al., 2018). These effects in early childhood also include reduced attention span and learning difficulties, which makes it difficult for children to retrain information (Slamberova, 2019).

Type of studies: Studies with qualitative, quantitative and mixed method methodologies were considered during this review. All research designs were considered to ensure that the most recent knowledge and developments regarding the topic were reviewed. Studies eligible for inclusion addressed the impact of maternal methamphetamine (*tik*) use on the cognitive development and school readiness of children in ECD. Studies included were accessible through electronic databases at the University of the Western Cape library. The studies that

were accessible, full-text, published, peer-reviewed, and English medium articles were considered for inclusion.

4.4.2 Exclusion criteria

Studies that were not published within the designated time period that is not accessible on the University of Western Cape libraries databases or within the public domain were excluded from the study. Studies that are not peer-reviewed or full text, which require payment and those published in foreign languages were excluded. Studies that did not include the specified target population and did not report on the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development were excluded.

4.5 Method of Review

The way in which the initial study and data retrieval was done by the primary researcher (AW) who conducted the study independently by using and entering Boolean strings of search terms and keywords into the preselected databases to identify potential titles at the identification level. The primary researcher then assessed and screened the relevant titles and their abstracts. After the removal of duplications across database searchers, eligible titles were identified by the primary researcher (AW) and considered appropriate for the current study. Then, a full-text review of each appropriate study was conducted independently by the primary researcher (AW) and the supervisor (CJE) who acted as the second reviewer. The full-text studies were subjected to the critical appraisal to assess the methodological quality and those studies were appraised by two independent researcher (AW) and (CJE) in order to evaluate the findings independently to ensure reliability and unbiased findings of the current study. Before the eligibility of studies, the two reviewers decided that any disagreements or disputes regarding eligibility and inclusion would be discussed until a consensus between the two reviewers was reached for the final inclusion of the study. However, the two reviewers established no disagreements regarding the inclusion and appraisal of studies.

4.6 Search Strategy

The search strategy utilised is from the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA), which are illustrated within four levels of review: identification, screening, eligibility, and inclusion (Moher et al., 2009). The following databases on the University of Western Cape library: Academic Search Complete, PubMed, SA ePublications (Sabinet), SAGE Journal Online, PSychArticles, and Science Direct were used for the identified keywords searches. The PRISMA levels of review are depicted in Figure 4.1 below:

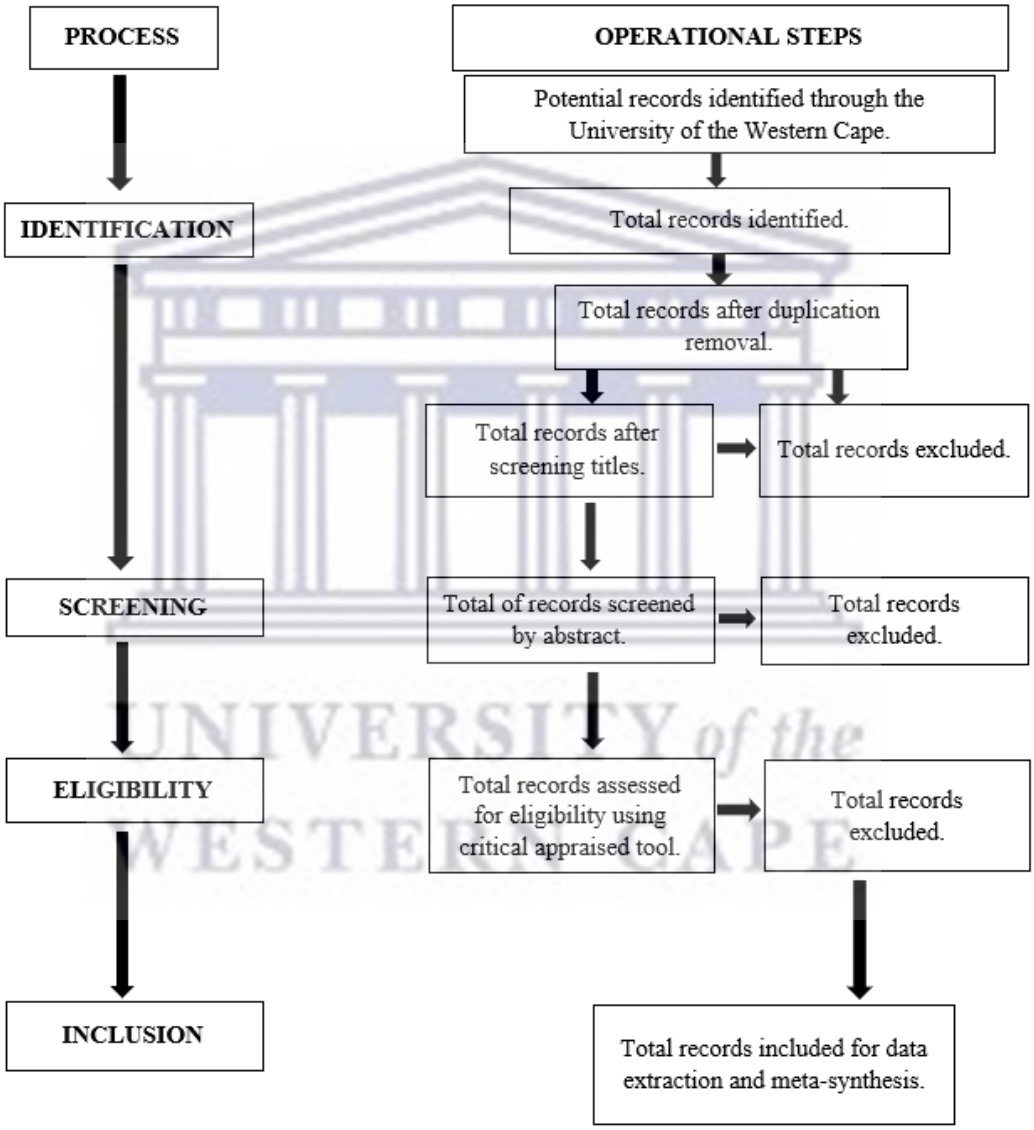

Figure 4.1: PRISMA levels of review (Source: Moher et al., 2009).

4.7 Levels of the Review

The four levels of review were: Identification, Screening, Eligibility and Inclusion respectively. The sub-sections below provide a narrative of the strategies and instruments used at each level.

4.7.1 Identification of potential titles

In the identification level of the retrieval strategy, keywords were taken from the title of the study in order to identify appropriate literature for the study (Moher et al., 2009). The keywords were selected using the PEO method/model for forming research questions. The PEO Model was developed to provide a framework for developing and framing a research question (Law et al., 1996) and to help you create a search strategy for finding research to answer a research question. Therefore, the initial search terms that were identified were "children in early childhood", "exposure to maternal methamphetamine", cognitive development and school readiness", and these keywords were entered into two electronic databases – PubMed and Academic Search Complete. In order to establish the effectiveness and success of the keywords determined by the number of hits (number of studies relating to the topic) they produced during the search process of the given two databases. However, the initial keywords restricted searches and resulted in a low number of hits (studies). This resulted in identifying additional search terms and keywords by using synonyms to enhance search terms and keywords. A robust set of search terms and keywords were identified as "effects", prenatal methamphetamine", "cognitive outcomes", and school performance". The strength of the keywords was tested on three separate databases, namely, Academic Search Complete, PubMed, and SA ePublications – based on the number of hits (study matches), the keywords received determined the strength thereof. A thorough search used the "AND" Boolean operator to further ensure the reliability and effectiveness of the results. Boolean strings are for the purpose of a comprehensive search of databases (Moher et al., 2009) and restrict searches, prompting potential matches and

increasing relevant data. The keywords formed three sets of Boolean strings, which are illustrated below:

1. ‘Effects of prenatal methamphetamine’ AND ‘on children’ AND ‘cognitive outcome’
2. ‘Maternal methamphetamine’ AND ‘cognitive development’ AND ‘school readiness’
3. ‘Methamphetamine’ AND ‘cognitive performance’ AND ‘ECD’

The six databases accessed from the University of Western Cape library were: Academic Search Complete, Pubmed, SA ePublications (Sabinet), SAGE Journal Online, PSychArticles, and Science Direct. These databases were associated with different disciplines that related to the research question. The research question related to the identified disciplines associated with the databases. The different databases were perused to establish which database would best suit the research question. During the level of identification, potential studies were selected upon the relevance of their titles to the current review. The relevant titles were recorded on an Excel sheet to keep a record of the potential studies.

Potential titles deemed relevant to the current review progressed to the next level of review, namely, screening. With the aforementioned Boolean strings, a comprehensive search was conducted across the databases (arranged according to their disciplines) available from the University of the Western Cape (UWC) online database. In Table 4.1, the disciplines and their corresponding databases are presented in an attempt to identify a set of core and secondary databases across disciplines.

Table 4.1: Table of disciplines and associated Databases

Natural Sciences	Social Science	Education & Health
BioMed Central	African Development Indicators	Academic Search Complete
BioOne	The African Journal Archive	EbscoHost Web
Health Source: Consumer Edition	AnthroSource	Emerald eJournal Premier
Health Source: Nursing Edition	Cambridge Journal Online	MasterFile Premier
Medline (Pubmed)	CINAHL	SA ePublications
Medline (EbscoHost)	JSTOR	Wiley Online Library
PubMed	Nexus	
ScienceDirect	Oxford Journals Online	
SCOPUS	PsychARTICLES	
	Sabinet African Journal Archive	
	Sage Journal Online	
	SocIndex	

4.7.2 Screening of Abstracts

The abstracts were reviewed according to the programmed inclusion and exclusion criteria during the level of identification by the researcher (Moher et al., 2009). During the level of screening, the abstract of each potential title was screened independently by the primary researcher for relevance to the review. Such assessment was determined against the inclusion and exclusion criteria. Studies that met the criteria were included, and those that did not meet the criteria were excluded from the study (Moher et al., 2009). Deciding on the inclusion of the studies, attention was paid to the inclusion criteria: the time period, participants, the type of study and the articles available from the University of Western Cape database. Those studies that did not meet the inclusion criteria were excluded from the next level of review. Studies that were not included did not move to the next stage and were utilised in the literature review chapter or other chapters where needed. Included studies moved on to the next stage of full-text eligibility. The information of all the abstracts and their outcomes were recorded on the Abstract Sheet (*Appendix C*).

4.7.3 Evaluating of full text for eligibility

All articles that moved on to this level of review, their full text of all eligible abstracts were reviewed and assessed independently by the primary and secondary researcher for methodological rigour for the current study using a self-constructed appraisal tool. The researcher undertook a methodological appraisal during the eligibility, which is important for quality, trustworthiness and accuracy. A joint decision was made regarding the included and excluded studies by the primary and secondary reviewers. Below is an in-depth description of the critical appraisal tool and its threshold score for eligibility.

4.7.3.1 Critical appraisal tool

The study reviewed studies with qualitative, quantitative and mixed method methodologies. Appraisal tools were constructed for qualitative, quantitative and mixed methods to evaluate the methodological rigour and relevance of the study. The critical appraisal tool chosen for the study was developed by Law et al. (1998) and used as a guideline for assessing the included studies. In order to assess the full-text reviews of the included studies, The Critical Appraisal Skill Program (CASP) (2014), a critical appraisal tool, was deemed appropriate for the current study. The critical appraisal tool aims to provide a comparative evaluation of research. Moreover, it is classified into research that is design specific. It addresses methodological issues unique to the research design (Katrak et al., 2004). The Critical Appraisal Tool consists of eight sub-sections: the study purpose, study design, sampling, data collection, data analysis, findings, conclusion and ethical considerations. The sub-sections of the critical appraisal tools allow for the methodological quality of the included studies (Siering et al., 2013). Using The Critical Appraisal Skill Program (CASP) assesses the methodological quality of the studies that were included for the relevance of the current study.

The CASP was developed to assess both qualitative and quantitative methodology, which led to the further development of The Evaluative Tool for Mixed Method Studies, consisting of eight subsections. Each of these Appraisal Tools has a rating scale to rate the quality of the studies being reviewed. In addition, the Critical Appraisal Tools also allow for independent assessments and a better reviewing process (Siering et al., 2013). Therefore, creating a space for the researcher to be impartial to the obtained results.

Three critical appraisal tools were developed for the independent assessment of quantitative (*Appendix E),* qualitative (*Appendix D*) and mixed method (*Appendix F)* studies within this review. The tools were reviewed by both the primary and second reviewers for a collective understanding of appraisal tools and scoring techniques.

4.7.3.2 Threshold score

The Critical Appraisal Skill Program (2014) allows for all fully reviewed studies to be given a percentage indicating their methodological rigour and overall quality from weak (0-30), moderate (31-65), strong (66-80) and excellent (81-100). The threshold score for the studies allows for a representation of the validity and reliability of the current study in order to draw conclusions from the studies (Hemingway & Brereton, 2009). Studies below the threshold stipulated in the category strong were excluded. In addition, studies not focusing on the impact of maternal methamphetamine on the cognitive development and school readiness of children in ECD were excluded from the current study.

4.8 Data Extraction

Data extraction is aimed at consistently extracting important information in the various sections of each study (Moher et al., 2009) for the findings to be synthesised and interpreted later (Kitchenham, 2004). Once the data was extracted and reviewed, it was ready to be analysed to record the findings. The data extraction sheet was constructed along the guidelines outlined in

the Cochrane Data Extraction & Assessment Form (Higgins & Green, 2011), with the following three sections: general description, methodology, and finding and analysis. A detailed description of the data extracted and the self-constructed data extraction (*Appendix G*) sheets are presented in Chapter 5.

4.9 Data Analysis

In order to gain a qualitative understanding of the findings, a meta-synthesis analysis was used to analyse the given data. The process of data analysis is a simple descriptive evaluation of each study commonly presented in a table form (Wright et al., 2007). It is the synthesis's interpretation of the interpretations of primary data by the original authors of the fundamental studies (Zimmer, 2006). Meta-synthesis is a "concept that includes several methodologies in synthesising qualitative research findings" (Korhonen et al., 2013, p. 4) that can lead to new interpretations of research. A meta-synthesis aims to generate new information and understanding of the research findings. Therefore, the quality of the meta-synthesis depends on the quality of the included studies that were critically appraised (Korhonen et al., 2013). There are three meta-synthesis stages: reciprocal stage, the refutational stage, and the line of argument stage. The reciprocal stage identifies recurring themes and ideas within the systematic review (Noblit & Hare, 1988). During this process, the researcher does a title search of the research topic to identify frequent themes emerging. The refutational stage identifies the themes and ideas that go against the common ones. The refutational stage is defined as themes and ideas that come to opposition conclusions from the main body of the work in a particular research area (Noblit & Hare, 1988). During this stage, the common themes and ideas of the research allow the researcher to understand the topic better. The line of argument stage is making a statement summarising and expressing what has been found. The line of argument stage identifies similarities and differences across studies on the current research question (Noblit & Hare, 1988). This stage will provide more insight into the common differences

concerning the themes and ideas. A meta-synthesis is deemed suitable for the current study as it provided a holistic understanding of the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development.

4.10 Ethical Consideration

Permission to conduct the review was requested from the Biomedical Research Ethics Committee (BMREC) of the University of the Western Cape. As identified by Wager and Wiffen (2011), there are three good practices in publishing a review; namely, avoiding redundant (duplicate) publication, avoiding plagiarism, and transparency (Wager & Wiffen, 2011). The three good practices ensure that potential conflict of interest is acknowledged, the review does not contain plagiarised material, and all contributors are recognised and accredited (Wager & Wiffen, 2011). In addition, the researcher's ethical responsibilities are a commitment to respecting the moral rights of authors and not forging parts of results and intentional manipulation of data analyses (falsification) (Darvishpour et al., 2014).

4.11 Chapter Summary

This chapter explained and outlined the methodology that the study followed in order to obtain the results for the current study. The systematic review methodology was expounded upon and why it was deemed appropriate for the current study. The process of executing a systematic review was defined and explicated with detailed steps that were taken to obtain the results of the study. Furthermore, the process of data analysis, meta-synthesis analysis, was described and outlined in this chapter. Lastly, the ethical considerations were explored and explain in relation to the current study.

CHAPTER FIVE

RESULTS

5.1 Introduction

This chapter comprises the findings of the current study and provides a complete understanding of the given study's findings. In order to determine the findings, a meta-synthesis data analysis was used. The data extraction process was done in three categories: general description, methodology and findings and analysis using a self-constructed data extraction appraisal tool. The chapter consists of the process of results, data extraction and the interpretation/discussion of the results.

5.2 Process of Results

The results and findings are in the four levels of review, adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA model aim is to help authors improve the reporting of systematic reviews and meta-analyses (Liberati et al., 2009). The process of results will be discussed according to the four levels of Identification, Screening, Eligibility and Inclusion, which descriptively outline the research findings extracted at each level of review respectively. The data was collected and extracted using data extraction sheets, focusing on the three sections of the "general description", "methodology", and "findings and analysis". Figure 5.1 illustrates the completed levels of review, which are followed by a descriptive explanation of each level in determining the results.

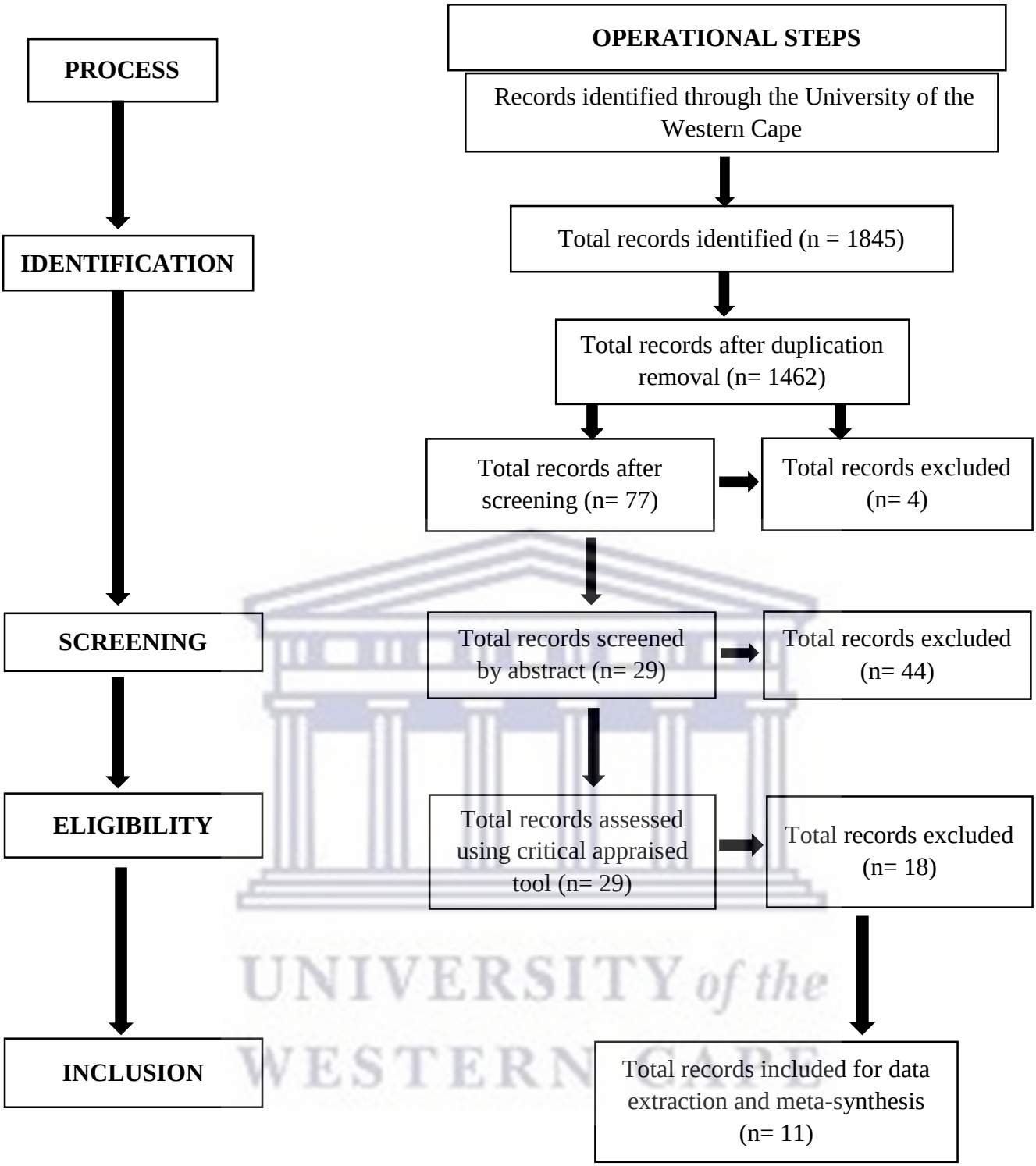

Figure 5.1: Process results per level and operational steps

5.2.1 Level 1: Identification

Data collection started with a title search across the identified databases on the University of the Western Cape library website. Advanced searches were limited to 10 years from (2010 - 2020). The search generated a result of 1845 potential hits recorded across all six identified databases. As a result, a number of 1462 duplicate records were removed across the six databases. The 383 remaining articles/studies titles were assessed, of which 77 titles were identified for possible inclusion. After a second review of the titles recorded in an Excel sheet, an additional 4 duplicate studies were removed. Therefore, leaving 73 possible titles for inclusion in the current study.

5.2.2 Level 2: Screening

During the abstract screening process, the 73 titles that were considered for possible inclusion were screened. Each of the 73 studies' abstracts was thoroughly assessed by the primary reviewer. Of the 73 abstracts assessed, only 29 met the requirements, measuring it against the inclusion and exclusion criteria. Only the studies that report on the "*impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development*" and falling into the stated time period (2010-2020), full text, published, peer-reviewed and English medium articles were considered for inclusion. The remaining 44 studies that were excluded were excluded based on the exclusion criteria, which are not peer-reviewed or full text, which require payment, those published in foreign languages were excluded, and studies not addressing the research question. Those 44 excluded articles were marked red on the abstract summary sheet and noted to be excluded from moving on to the next level.

5.2.3 Level 3: Eligibility

The full-text versions of the 29 studies included at the screening level were assessed for eligibility for the current study. The way in which eligibility was assessed and determined was by using the critical appraisal tool in order to assess the full text for inclusion in the current study. Studies of qualitative, quantitative and mixed methods were appraised. After appraising the 29 studies, the primary reviewer identified 12 studies to be eligible for inclusion. All 29 studies the primary reviewer assessed were sent to the secondary reviewer, with the full text, for assessment. After the secondary reviewer assessed the studies, the primary and secondary reviewers decided to include 11 eligible studies.

5.2.4 Inclusion

These 11 studies met all the methodological requirements in order to be included in the current study. The final 11 studies that were included moved on to the process of data extraction and meta-synthesis. The process of data extraction is outlined below.

5.3 Findings and Analysis

5.3.1 General Description of the Studies

This section summarises the general details of the included studies, such as; the target population, demographic variables, geographical location, and the aim/problem statement. A general description of the aforementioned is presented in the table below.

Table 5.1: General description of studies

Authors	General Description			
	Target population	**Demographic Variables**	**Geographic Location**	**Aim/problem statement**
Abar et al., **2013**	A sample of 320 mother–infant dyads (162 PME) was followed from birth through 6.5 years of age.	Los Angeles, CA, Des Moines, IA Tulsa, OK, and Honolulu, HI	United States.	• To examine the extent to which prenatal methamphetamine exposure (PME) was predictive of childhood neurobehavioral disinhibition (ND). • To explore the extent to which early adversity mediated this relationship.
Twoney et al., **2013**	Infants of 1, 12, 24, 30 months and 5 years old.	Honolulu, Hawaii, Los Angeles, California, Tulsa, Oklahoma, and Des Moines and Iowa.	United States.	• To examine child behaviours and how it would be adversely impacted by prenatal MA exposure. • Look at how home environments that provide less developmental stimulation and emotional responsiveness to the child and the presence of PC psychological symptoms and other risk factors.
Chakraborty et al., **2015**	One hundred and forty-five 4.5-year-old children who had been exposed to different combinations of methamphetamine prior to birth, and 25 unexposed children.	Not specified.	New Zealand.	• To investigate the effect of prenatal drug exposure on global motion perception, a behavioural measure of processing within the dorsal extrastriate visual cortex that is thought to be particularly vulnerable to abnormal neurodevelopment.
Häefele, **2012**	Mothers who used methamphetamine during pregnancy and teachers who work with methamphetamine exposed children.	Cape Town, Mitchell's Plain.	South Africa.	• To explore the impact of maternal methamphetamine abuse on children's cognitive development and functioning at schools.
Prinsloo & **Ovens**, **2018**	102 pregnant women or known to have given birth to a child or children while abusing illegal drugs and other harmful substances.	Cape Town, Mitchell's Plain.	South Africa.	• The study research initiative focuses on the phenomenon of maternal psychoactive substance abuse in Mitchell's Plain area in the Western Cape. It proposes a model of ecological development as the basis of intervention efforts.

Häefele, **2011**	Teachers (4), a grandmother whose daughter used methamphetamine during pregnancy (1) and a dentist (1).	Cape Town, Mitchell's Plain.	Western Cape, South Africa.	• To explore and to describe the effect of prenatal Methamphetamine abuse on children's early childhood behaviour.
Smith et al., **2015**	204 mother-infant dyads. Children from birth to 7.5 years.	Four clinical sites (Los Angeles, CA; Des Moines, IA; Tulsa, OK; Honolulu, HI) with an elevated prevalence of MA use compared with other areas in the United States and New Zealand.	United States.	• To determine the maternal outcome, child growth, and developmental findings following prenatal methamphetamine exposure from birth up to age 7.5 years.
Smith at al., **2011**	412 mother-infant pairs. Children aged from 1-3 years.	At four sites (Tulsa OK, Des Moines IA, Los Angeles CA, and Honolulu HI).	United States.	• To examine the effects of prenatal MA exposure on motor and cognitive/ development in children at 1, 2, and 3 years of age.
Kiblawi et al., **2014**	412 infants (one month old) and their mother.	Honolulu, Hawaii, Los Angeles, California, Tulsa, Oklahoma, and Des Moines and Iowa.	United States.	• To investigate how MA use during pregnancy affects neonatal and infant neurobehavioral.
Shah et al., **2012**	Methamphetamine-exposed children.	Honolulu, Hawaii, Los Angeles, California, Tulsa, Oklahoma, and Des Moines and Iowa.	United States.	• To examine maternal and infant medical outcomes of prenatal exposure to methamphetamine (MA).
Gorman et al., **2014**	Children born from methamphetamine and their birth mother.	The state of California.	United States.	• To examine the effects of methamphetamine use on various maternal and neonatal outcomes.

As presented in the table above, the 11 studies which have met the inclusion criteria in respect of the target population, which were either children between the ages of 0-6, born to maternal methamphetamine (tik) use or pregnant women known to have given birth to a child or children using methamphetamine (tik). A number of studies (*n*=7) used a suitable target population which comprised of mothers who used methamphetamine during pregnancy, and children born from methamphetamine, to explore the impact of maternal methamphetamine on the cognitive development and school readiness of children in early childhood development (Abar et al., 2013; Twoney et al., 2013; Häefele, 2012; Prinsloo & Ovens, 2018; Häefele, 2011; Smith et al., 2015; Smith et al., 2011). Another two (*n*=2) studies included sampled teachers, a health professional (dentist) and a caregiver (grandmother) to gain more insight into the impact and experience relating to maternal methamphetamine use and the effect it has on cognitive development and therefore affecting their school readiness (Häefele, 2012; Häefele, 2011). The geographical location of the included studies was divided across United States (*n*=7) - Abar et al. (2013) in Los Angeles, Des Moines et al. (2013) in United States; Twoney et al. (2013) in Los Angeles; Smith et al. (2015) in Los Angeles; Smith et al. (2011) in Los Angeles; Kiblawi et al. (2014) in Los Angeles; Shah et al. (2012) in Los Angeles; Gorman et al. (2014) in California, United States. South Africa (*n*=3) – Haefele (2012) in Cape Town; Prinsloo & Ovens (2018) in Cape Town; Haefele (2011) in the Western Cape, South Africa. New Zealand (*n*=1) – Chakraborty et al. (2014) in New Zealand. All the included studies aimed to explore, examine and describe the impact of maternal methamphetamine use on children cognitively and how it impacts their readiness for school.

5.3.2 Methodology of the Studies

The methodological appraisal of the data extracted reports on the included study's design, theoretical underpinning, sampling methods and size, and the data collection instrument/s. This data is presented in Table 5.2.

Table 5.2: Methodological appraisal of studies

Authors	Methodology				
	Study Design	**Theoretical underpinning**	**Sampling method**	**Sample size**	**Data collection method/instrument**
Abar et al., **2013**	Quantitative Study Design	Not specified.	Purposeful sampling	412 participated in the study.	• The child's behavioural and emotional control using the Child Behaviour Checklist (CBCL). The scale developers' recommendations, seven symptom summary scores were derived, including emotionally reactive, anxious/depressed, withdrawn, sleep problems, aggressive, and somatic complaints. • The Children's Memory Scale is a standardized test involving an interaction between an examiner and child, designed to assess multiple dimensions of memory, with the current study using standardized indices of attention/ concentration, delayed recognition, and general memory.
Twoney et al., **2013**	Quantitative Study Design	Not specified.	Purposeful sampling.	97 MA-exposed and 117 comparison children.	• A Child Behaviour Checklist (CBCL) for ages 1½ to 5 is a 113-item rating scale that measures child social, emotional, and behavioural problems. At 30 months, the Infant–Toddler HOME was conducted in the child's identified psychological symptom patterns. • The Parenting Stress Index is a 36-item scale that measures parenting stress using a 5-point Likert scale on which items are rated from strongly agree to strongly disagree. • Lastly, the Substance Use Inventory (SUI) was used to determine the frequency and quantity of MA and other illicit drugs, alcohol, and tobacco used by the child.
Chakraborty et al., **2015**	Quantitative Study Design	Not specified.	Not specified.	One hundred and forty-five 4.5-year-old children.	• The IDEAL study cohort was assessed at 4.5 years of age. Measures of visual function were included in the 4-5-year assessment protocol because 4.5-year-old children are capable of completing behavioural measures of visual acuity and global motion perception.

Häefele, **2012**	Qualitative Study Design	The Social Disorganisation Theory.	Purposeful sampling is based on geographical location and due to time constraints.	Seven teachers from the four different schools in Mitchell's Plain.	• Teachers completed qualitative scheduled questionnaires. • In-depth interviews were also conducted with 16 mothers who used methamphetamine during pregnancy.
Prinsloo & **Ovens**, **2018**	Qualitative Study Design	Ecological Systems Theory	Purposive sample.	102 women	• Data collection took place in the form of semi-structured, in-depth interviews facilitated by an interview schedule comprising structured and open-ended questions to record the data in a structured format.
Häefele, **2011**	Qualitative Study Design	Not specified.	A convenient sample.	43 primary schools in Mitchells Plain. The researcher included 4 primary schools, a grandmother of a Methamphetamine exposed child and a dentist at a clinic.	• In a qualitative research, the author used scheduled questionnaires and in-depth interview tools (semi-structured, in-depth interviews) that are employed in the data collection.
Smith et al., **2015**	Quantitative Study Design	Not specified.	A convenient sample.	Mothers with prenatal MA use (n=204) and matched unexposed comparisons (n=208) were enrolled for longitudinal follow-up.	• Review of studies. • All published studies reporting maternal and child outcome data using the Infant Development, Environment, and Lifestyle Study (IDEAL), a multisite, longitudinal, prospective study designed, were included in this review in order to determine the findings.
Smith at al., **2011**	Quantitative Study Design	Not specified.	A convenient and purposeful sampling.	MA subjects (n=204) and Comparison subjects (n=208) were matched.	• The Peabody Developmental Motor Scales (PDMS-2) were administered to the infants at the 1- and 3-year visits. • The Bayley Scales of Infant Development (BSID-II). PDMS-2 and BSID-II examined the effects of MA exposure.
Kiblawi et al., **2014**	Quantitative Study Design	Not specified.	A convenient sample.	Exposed *n*=185, Comparison *n*=195	• A medical chart review and a recruitment Lifestyle Interview were performed to acquire information about prenatal substance use and maternal and newborn characteristics. • An NNNS exam was administered to all subjects born at term within the first 5 days of life by certified examiners masked

					to MA exposure status. The NNNS is a standardised neurobehavioral exam for healthy and at-risk infants that assesses neurological, behavioural, and stress/abstinence neurobehavioral functioning.
Shah et al., **2012**	Quantitative Study Design	Not specified.	A convenient and purposeful sampling.	204 MA-exposed and 208 unexposed matched comparisons.	• Results of meconium drug testing. • A maternal interview (the Recruitment Lifestyle Interview) was conducted. • For each drug used during pregnancy, a second interview, the Substance Use Inventory, was conducted. • As well as The IDEAL study is a multi-site, longitudinal study.
Gorman et al., **2014**	A retrospective cohort study that included all pregnancies from 2005 through 2008. (Quantitative Study Design).	Not specified.	A convenient sample.	8542 pregnancies (0.4%) that were linked to a diagnosis of methamphetamine use were identified and compared with 2,031,328 control pregnancies	• The data for these calculations were derived from linked mother-infant datasets from the California Vital Statistics Birth Certificate Data, Vital Statistics Death Certificate Data, California Patient Discharge Data, and Vital Statistics Fetal Death File.

The 11 included studies, as presented above in Table 5.2, employed (*n*=8) quantitative study designs and (*n*=3) qualitative study designs in order to examine the impact of maternal methamphetamine use on the cognitive development and school readiness of children in ECD. Of the included eight quantitative studies, the six studies by Abar et al. (2013); Twoney et al. (2013); Smith et al. (2015); Smith et al. (2011); Kiblawi et al. (2014) and Shah et al. (2012), employed an Infant Development, Environment, and Lifestyle Study (IDEAL), which is a multisite, longitudinal, prospective study design. The study of Gorman et al. (2014) employed a separate cohort study. The quantitative study of Chakraborty et al. (2015) failed to report on the study design used within this study. The three included qualitative studies (Häefele, 2012; Häefele, 2011; Prinsloo & Ovens, 2018), employed scheduled questionnaires, and semi-structured and in-depth interviews. Only two of the (*n*=11) included studies reported on the theoretical underpinning of their studies. Häefele (2012) employed the social disorganisation theory, whereas Prinsloo and Ovens (2018) used the ecological systems theory.

Of the (*n*=11) included studies, (*n*=4) studies employed purposeful sampling (Abar et al., 2013; Häefele, 2012; Prinsloo & Ovens, 2018; Twoney et al., 2013) and (*n*=4) studies employed convenient sampling (Gorman et al., 2014; Häefele, 2011; Kiblawi et al., 2014; Smith et al., 2015). While (*n*=2) studies employed purposeful and convenient sampling methods based on the physical location of the studies (Shah et al., 2012; Smith et al., 2011). Chakraborty et al. (2015) failed to clearly report on the sampling method. The sample size ranged from 7 to 8542 participants, including MA-exposed children, mothers, teachers and a health practitioner (Gorman et al., 2014; Häefele, 2012; Smith et al., 2015). The data collection method commonly used was a variety of psychometric measures, consisting of the Child Behaviour Checklist (CBCL) (Abar et al., 2012; Twoney et al., 2013), The Parenting Stress Index scale by Twoney et al. (2013), Measures of visual function by Chakraborty et al. (2015), The Peabody Developmental Motor Scales (PDMS-2) in Smith et al. (2011), NNNS, a standardised

neurobehavioral exam in Kiblawi et al. (2014), and meconium drug testing in Smith et al. (2011) and Shah et al. (2012). Scheduled questionnaires, semi-structured and in-depth interviews were used by Häefele (2012), Prinsloo and Ovens (2018) and Häefele (2011). Lastly, two studies utilised study review methods (Gorman et al., 2014; Smith et al., 2015).

5.3.3 Findings and Analysis

This section descriptively summarises the findings of the included studies, such as the results/evidence/findings, conclusions, recommendations and limitations of the included studies. Table 5.3 below provides the extracted data and its respective sections.

Table 5.3: Findings and Analysis

Author	Findings and Analysis			
	Results, Evidence, Findings	**Conclusion**	**Recommendations**	**Limitations of Study**
Abar et al., **2013**	• The study found that Prenatal Methamphetamine Exposed (PME) infants were exposed to significantly more tobacco, alcohol, and marijuana in utero than comparison infants. • Results indicated that, at 5 years of age, Prenatal Methamphetamine Exposure children were significantly more emotionally reactive, anxious and/or depressed, and aggressive than comparison. • The study established chaotic and unsafe environments fostered by maternal methamphetamine use, which were strongly associated with childhood behavioural, emotional, and cognitive deficits.	• The study highlights the potential importance of PME on child development and a potential mechanism by which effects are observed.	• The study recommends that future research examining Prenatal Methamphetamine Exposure should seek to incorporate reports from other parties as well as additional objective measures when doing follow-ups and not only from the parent of the children.	• The limitation of the study indicates that limited human work has examined the potential relationship between maternal use of methamphetamine during pregnancy and later child neurobehavioral disinhibition. • As well as, the measurement of the executive function latent variable did not completely cover the range of the construct, lacking a focus on goal setting/progressive planning of the study.
Twoney et al., **2013**	• The findings of this study are that prenatal MA exposure was associated with child externalizing behavioural problems at 5 years. • It also found that the home environments that were more responsive to children's developmental and emotional needs were associated with a decreased risk of internalizing and externalizing behavioural problems. • The parenting stress and psychological symptoms experienced by primary	• Understanding determinants of early childhood behavioural outcomes is complicated by many factors that can be difficult to control for, such as genetic vulnerabilities, child temperament, life experiences, quality of relationships, social support, and availability of community resources to support families with young children. • Longitudinal follow-up can further determine the behavioural trajectories of children with prenatal MA exposure as they move into school settings	• Identification of behavioural problems in the preschool years can contribute to understanding developmental trajectories and identifying approaches to prevention. • Early identification of emergent behavioural problems can lead to interventions to support more adaptive functioning.	• Because of the increased use of tobacco, alcohol, and marijuana in mothers who used MA during pregnancy, the contribution of these other drugs may be masked.

	caregivers were associated with increased child behavioural problems.	where they face increased academic, social, and behaviour problems.		
Chakraborty et al., **2015**	• The results indicate that 1) global motion perception, a behavioural measure of extrastriate cortex (visual function), is susceptible to the effects of prenatal drug exposure. • And 2) interaction effects occur when children are exposed to multiple drugs. • Prenatal MA exposure has negative developmental effects on children.	• Many mothers of methamphetamine-exposed children were poly-drug users. • It has shown that recreation drugs have different effects on preschool children.	• More studies need to be conducted on how different recreational drugs affect children.	Not specified.
Häefele, **2012**	• The personality and cognitive disabilities of methamphetamine exposed children identified by the teachers were delayed physical, academic and social development is noticeable. • There is memory loss, and in some cases, no memory (cannot remember). • The children need constant and consistent re-teaching and repeating of instructions or information, i.e. no "sinking-in" processing or "taking on board" of the information, most children are academically poor, under average, and some children cannot recognise sounds, and cannot put words/sentences together. • Most of them show a very basic understanding of mathematics.	• Most mothers are aware of the dangers of substance abuse but continue using it throughout their pregnancies. • Only four of the 16 mothers stopped using substances for a short period during the pregnancy. • The characteristics of methamphetamine exposed children include cognitive abnormalities such as learning disabilities and deviant behaviour.	• Future studies could explore legislation regarding prosecuting mothers of drug-exposed babies in South Africa. • In other countries, the delivery of drug-exposed babies faces the possibility of prosecution. • In South Africa, child abuse is a crime, but the law does not consider the abuse of drugs during pregnancy as a crime.	There is not only a lack of research on prenatal substance abuse and drug dependency in the pregnant mother but also limited research on prenatal drug abuse as a form of child abuse.
Prinsloo & **Ovens**, **2018**	• Results show that approximately 85 per cent of the participants gave birth while still using drugs, indicating that they were physically and/or emotionally dependent and could probably not stop.	• The ecological systems theory incorporates the role of factors that influence the health of mothers who abuse psychoactive substances during	• There is inequitable access to substance abuse treatment for maternal methamphetamine use. • Women live in poverty, and the placement of culturally	Not specified.

	• Furthermore, almost 26 (25.5%) of the women in this study experienced difficulties bonding with their new-born babies. • Maternal psychoactive substance abuse remains a long-term problem that influences a child's neurodevelopment and affects mental and physical health. • The study's findings explain how the ecological systems theory relates to different areas of the participants and how that affects the vulnerable child exposed. It has effects on their social-ecological, personal, community and environmental circumstances.	their pregnancies and their mental wellbeing within the community. • Therefore, if maternal substance use is viewed within a socio-ecological frame, it transfers the focus from the substances and places it on the mother's health behaviours and skills needed to cope with and manage her life	appropriate facilities dispersed within the neighbourhood will improve efforts to target harm reduction and promote recovery. • This might encourage them to seek treatment once they find out they are pregnant.	
Häefele, 2011	• The use of Methamphetamine can cause a limited flow of oxygen to the foetus, which can lead to low birth weight. • Babies can be born addicted to Methamphetamine and suffer withdrawal symptoms, including tremors, sleeplessness, muscle spasms and feeding difficulties. • Methamphetamine during pregnancy indicates the problems Methamphetamine exposed children experience at school. • Methamphetamine mothers had even more dramatic changes than babies whose mothers use alcohol. For instance, the caudate nucleus, which helps process learning and memory, was smaller in babies exposed to Methamphetamine. • Methamphetamine-exposed children have difficulty in making transitions regardless of their level of intelligence.	• Methamphetamine-exposed children include cognitive abnormalities and deviant behaviour. • MA-exposed children need special education, adaptive learning skills and supportive care. • Programmes are available to support and encourage vulnerable young women to seek further education, job-training and supportive and treatment services. • However, the willingness of pregnant drug addicts to commit to treatment programmes remains an unanswered question.	• There is a dire need for further longitudinal research on prenatal drug abuse as a form of child abuse. • Further research is needed to establish the link between prenatal Methamphetamine use and exposed children's dental development.	• This research project confirms the limited research on prenatal drug abuse as a form of child abuse and recommends further research on this controversial topic.

	• Learning difficulties include poor memory, numeracy, reading and writing, language comprehension and problem-solving skills.			
Smith et al., **2015**	• The study found that MA exposure was associated with increased externalizing behaviours and increased attention-deficit/hyperactivity disorder symptoms at age 5 years. • Prenatal methamphetamine was associated with subtle differences in attention processing. • In preschool, children are prenatally exposed to MA, suggesting the caudate nucleus impacts cognitive control processes. • The relationship between prenatal methamphetamine exposure, early childhood adversity and subsequent childhood was associated with behavioural and emotional control and deficits in executive function. • School-age children showed that heavy prenatal MA exposure was associated with reduced accuracy.	• The study's findings highlight the importance of interventions that address the child and parental or primary caregiver needs to optimize child outcomes.	• This study demonstrates the importance of providing rapid, comprehensive drug counselling services to women actively using methamphetamine during pregnancy to optimise the exposed child's long-term neurodevelopment.	• There are potential limitations to the IDEAL study. First, a substantial proportion of women declined to participate at an early stage in the study, and therefore, the findings may not be generalisable to all MA-using pregnant women. • It is possible that women who refused to participate would be likely to have more severe MA problems. A potential limitation of the study is that the exposed group of subjects is primarily based on self-report, and women may not have been able to recall the timing and amount of MA use during their pregnancy.
Smith at al., **2011**	• The study found poorer fine motor performance at 1 year in children exposed to prenatal MA exposure, with the poorest performance observed in the most heavily exposed children. • The findings suggest MA exposure children have modest motor effects at 1 year that are mostly resolved by 3 years, with no evidence of cognitive dysfunction noted in children MA-exposed.	• The study suggests no significant differences in cognitive function in MA-exposed children relative to the comparison group. • The MA-exposed children had fine motor deficits at age 1, which was no longer appreciated at age 3. • Longitudinal follow-up is critical to determine if these drug-associated effects lead to motor and/or cognitive	• It is recommended that a long-term follow-up of these MA-exposed children is critical because the Bayley assessment may not be able to ascertain subtle drug-associated effects of higher-order cognitive and executive functions at this young age.	• A limitation of this report is that the exposed group is primarily determined by self-report. In addition, because meconium production begins at 14-16 weeks gestation, meconium testing primarily reflects maternal drug use during the second and third trimesters.

	• Visual perceptual processing may be adversely affected, and these children may be at risk for poorer performance in task coordination, such as bicycle riding and other physical fitness activities.	impairments as the children progress to school age.		
Kiblawi et al., **2014**	• MA is considered potentially greater, given its significantly longer half-life and ability to function compared to other drugs. • MA exposure affects infant temperament in such a way that compounded with the environmental risk, would increase their risk of non-accidental trauma. • Exposed infants are susceptible to numerous risk factors related to both direct and indirect effects of MA exposure. • However, no significant main effects of exposure to MA were observed from birth to one-month infant.	• Long-term follow-up is required to detect and possibly prevent exacerbation of these subtle effects beyond infancy.	• It is important to continue following these children as they develop to monitor whether latent neurobehavioral effects emerge during childhood.	• The results should be interpreted with caution, as there are limitations to our study. • First, the exposed group of subjects was selected primarily based on self-report.
Shah et al., **2012**	• MA-exposed infants were likelier to exhibit poor suck, have smaller head circumferences and length, require neonatal intensive care unit admission, and be referred to child protective services. • Exposed infants have been associated with an increased likelihood of clefting and fetal growth restriction. • Prenatal MA use was associated with cardiac defects, low birth weight, and cerebral haemorrhage, among many other adverse outcomes.	• Prenatal MA exposure is associated with a maternal psychiatric disorder/emotional Illness. • Identifying substance-using pregnant women and the availability of comprehensive treatment programs remain a challenge for healthcare providers.	• Lack of prenatal care remains an issue for substance-using pregnant women. • Therefore, the importance of continued follow-up of infants prenatally exposed to MA to determine the predictive validity of these early medical complications. • Additional studies on how prenatal MA exposure impacts maternal and infant outcomes are still necessary.	• This study did not address whether there is a dose- or time-dependent relationship between MA exposure and medical outcomes. • It is also uncertain whether more severe concomitant drug use can account for the differences found. • This study did not examine the relationship between the total amount of MA used, the timing of MA exposure, and the likelihood or severity of problems.

	• MA exposure is associated with multiple maternal psychosocial risks, neurobehavioral patterns of decreased arousal, increased stress, poor movement quality, and increased prematurity and incidence of small for gestational age.		• Ongoing education and awareness by professionals are necessary to assist in overcoming the challenge.	
Gorman et al., 2014	• Results indicate that compared with control subjects, methamphetamine users have greater odds of a significant increase in hypertensive diseases of pregnancy associated with methamphetamine use compared with control pregnancies. • Methamphetamine use was associated with increased incidence and odds of hypertensive disorders during pregnancy. • There was again a statistically significant increase in neonatal death with maternal methamphetamine use. • An increased incidence and odds of low birth weight and small-for-gestational-age of neonates.	• Maternal methamphetamine use during pregnancy was found to be associated strongly with specific pregnancy outcomes that lead to increased maternal and foetal morbidity and death. • Several observations correlated well with existing data on the subject.	• Further work can be done to improve the care of pregnancies complicated by methamphetamine use to reduce these complications.	• The study was retrospective in nature and relied on ICD-9 codes for categorising all outcomes of interest. • This limits the sensitivity of ICD-9 codes in the identification of such exposures.

As presented above, the findings produced from the data analysis conducted by all the included studies (*n*=11) have indicated that the majority of MA-exposed children are impacted by maternal methamphetamine (MM) use and experience cognitive difficulties, which in turn affect their school readiness in early childhood development (ECD). While the impact of MM use has been reported on in the findings of the (*n*=11) included studies, the study by Smith et al. (2011) established that MA-exposed children who displayed modest fine motor performance difficulties, the motor effects were mostly resolved by age 3, with no evidence of cognitive dysfunction noted in MA exposed children. Likewise, the study by Kiblawi et al. (2014) concluded that no significant main effects of exposed MA infants were observed from birth to one month old. However, both these studies conclude and recommend longitudinal follow-ups as it is critical to determine drug-associated effects that lead to cognitive impairment as children progress to school, as these effects may emerge during childhood (Kiblawi et al., 2014; Smith et al., 2011). In comparison, the remaining (*n*=9) studies found that MM use has equally a direct and indirect effect on children, their cognitive development and their readiness for school during ECD (Abar et al., 2013; Chakraborty et al., 2015; Gorman et al., 2014; Häefele, 2012; Häefele, 2011; Prinsloo & Ovens, 2018; Shah et al., 2012; Smith et al., 2015; Twoney et al., 2013). These effects include; neuro-behavioural issues, an influence of neurodevelopment, the cognitive deficit in childhood, delayed academic development, learning difficulties and reduced accuracy when performing tasks.

Three of the included studies (Häefele, 2012; Häefele, 2011; Smith et al., 2015) reported on the direct relationship between MM use and children's cognitive development and how that impacts the children's school readiness of children in ECD. These (*n*=3) studies concluded that the characteristics of MA-exposed children include; cognitive abnormalities such as learning disabilities and that the caudate nucleus, which helps process learning and memory and impacts cognitive control processing, were smaller in babies exposed to methamphetamine. Most of the included studies recommended additional follow-ups and additional studies on prenatal MA

exposed children to understand the issue and determine the long-term impact of MM use. Abar et al. (2013) indicated that limited human work had examined the potential relationship between maternal use of methamphetamine during pregnancy. While conducting the study, limited research was available on the given research question, which makes it difficult for professionals and prenatal methamphetamine dependency pregnant mothers to truly understand the importance of the issue.

5.4 Chapter Summary

The current chapter has extracted all the essential data presented in the eleven included studies required to address the current study's research question, aim and objectives. The data has been extracted in three steps: general description, methodology, and findings and analysis. With the data extraction process complete, it enables the synthesis and interpretation of extracted data to be analysed, presented in the next chapter, Chapter Six.

CHAPTER SIX

DISCUSSION OF DATA ANALYSIS

6.1 Introduction

The current chapter is a synthesis and interpretation of the extracted data. This chapter is a theory explanation of the meta-synthesis, which is discussed in three sections: reciprocal translational, refutational synthesis and the line of argument, which was briefly discussed in Chapter Four. The reciprocal translational analysis aims to combine results by revealing and identifying themes and concepts from the findings of the included studies. The refutational synthesis attempts to come to opposition conclusions from the common themes and concepts that emerge from the included studies. The line of argument synthesis provides a broad summary and interpretation of the current study. It provides a better understanding of new information for future research on the impact of maternal methamphetamine (*tik*) use on children's cognitive development and school readiness in early childhood development (ECD).

6.2 Reciprocal translational

The reciprocal translational analysis identifies the key themes and concepts in each study (Noblit & Hare, 1988). In this first stage of the analysis, various themes emerged from the relevant literature from all eleven included studies on the impact of maternal methamphetamine (MM) on the cognitive development and school readiness of children in ECD. In addition, the following themes emerged from the current study; the influence of MM use on children's cognitive development, MM use and the effect on school readiness, and maternal methamphetamine use and ECD.

6.2.1 The predominance of maternal methamphetamine (MM) use

Methamphetamine (MA) was synthesised for the first time in Japan in 1893. German, English, American and Japanese military personnel, including civilian Japanese factory workers, used the drug during World War 11 for its energy-promoting and performance-enhancing properties (Haefele, 2012). After World War 11, the Japanese military dumped large supplies of MA on the civilian market, causing Japan's 'first epidemic' of MA abuse (Häefele, 2012). In the Western Cape, MA is the most common and primary substance of abuse when the brain absorbs high levels of MA, causing it to be a more potent stimulant drug (Häefele, 2012). Prinsloo and Ovens (2018, p. 2) indicated that "the rapid and extensive spread of MA remains a problem in the South African context and is a significant under-researched phenomenon". The prevalence of MA is a growing problem; maternal methamphetamine, in particular, is rising. The prevalence of MM use and abuse is high, and it remains a long-term problem making women account for a substantial subset of MA users (Kiblawi et al., 2014; Prinsloo & Ovens, 2018). Maternal substance abuse is described as a "multifaceted major public health problem with far-reaching global, intergenerational consequences that insidiously an incrementally threatens culture stability when its prevalence is high" (Prinsloo & Ovens, 2018, p. 101). MM has a prevalence of 14 to 57 million or 0.3 to 1.3% of all 14 – 64-year-olds using MA (Kiblawi et al., 2014), and 7.2% of pregnant women reported using MA as a primary drug of abuse (Gorman et al., 2014). MA use in women of reproductive age is a problem with a 14 to 57 million prevalence among 15-64 years old (Baker et al., 2022).

MA use has been found to be associated with sexual risk behaviour. A 2008 study found that adolescents engaging in MA within the past 30 days were significantly more likely to have had sex and experienced a pregnancy (Haefele, 2012). MA abuse is furthermore associated with sexual risk behaviours, which include having unprotected sex with multiple partners (Prinsloo & Ovens, 2018). Substance abuse by "expecting mothers has tripled over the past five years to

reach ‘epidemic proportions’ and a ‘crisis point’” (Prinsloo & Ovens, 2018, p. 101). MA using pregnant women symbolise a particularly important subpopulation, as literature has shown a comprehensive effect of prenatal MA exposure on the child's developmental outcomes (Abar et al., 2013). MM use impacts and affects the unborn child during pregnancy. Once born, the baby can be born addicted to methamphetamine and suffer from withdrawal symptoms that include sleeplessness and muscle tremors (Häefele, 2011). Children born of MM use show immediate physical characteristics, such as low birth weight and small head circumference and length (Gorman et al., 2014; Shah et al., 2012). The prevalence of MM use on children and their development affects children differently. The impact of MM use on cognitive development and school readiness in ECD leads to the following sub-themes: influence of MM use on children’s cognitive development, MM use and the impact of school readiness and maternal methamphetamine use and ECD.

6.2.1.1 Influence of MM use on children’s cognitive development

The influence of maternal methamphetamine (MM) use on children’s cognitive development was a reciprocal translational theme of the eleven included studies. This was the most common theme of the impact of MM use. The findings of the included studies indicate that MM use affects the unborn child during pregnancy, leading to cognitive impairment in the unborn foetus, which subsequently influences the child's cognitive development. Cognition refers to the “mental processes involving in the acquisition, retention and use of knowledge and the foundational aspect of cognitive development include attention, processing speed, representational competence (i.e., the ability to manipulate a mental image of an object or idea), and memory” (Irvine et al., 2022, p. 1). Children born of MM use show immediate physical characteristics, such as low birth weight and small head circumference and length (Gorman et al., 2014; Shah et al., 2012). Once more, tests and studies are done after birth on MM-exposed children. The findings show that MM-exposed children suffer from various cognitive

abnormalities affecting their neurodevelopment (Prinsloo & Ovens, 2018). A part of the brain called the cingulated cortex, which comprises emotion processing and conflict resolution, was larger in methamphetamine-exposed babies (Haefele, 2012). MM exposure to brain development can be detrimental to the child's development. MA exposure during development leads to spatial learning and reference memory (Smith et al., 2015), and MA exposure affects the brain structure and neurochemistry of the child (Abar et al., 2013). MA-exposed children experience neurocognitive deficits in visual motor integration, sustained attention, verbal memory and long-term spatial memory. The deficits in sustained attention and verbal memory were correlated with reduced volume in targeted brain structures (Smith et al., 2011). Prenatal and postnatal MA exposure frequently delays development, particularly in speech and language skills. Children may not meet development milestones and lack basic socialisation skills (Haefele, 2011). As a result of the smaller subcortical volumes comprising the putamen, globus pallidus, and hippocampus of the brain, thus possibly impacting attention and memory (Kiblawi et al., 2014), this indicates the impact of MM use on school readiness.

6.2.1.2 MM Use and the Impact on school readiness

The influence of MM use on children's cognitive development leads to the suffering from various cognitive abnormalities, which causes learning disabilities and difficulties impacting their school readiness (Abar et al., 2013; Häefele, 2012). In prenatal methamphetamine exposure, children suffer poorer psychosocial well-being and academic achievement (Abar et al., 2013). Teachers who taught children known to have been exposed to MM displayed characteristics such as delayed academic development, poor memory and reading, writing and language comprehension (Häefele, 2011). MA exposure was associated with increased attention-deficit/hyperactivity disorder symptoms at age 5 years (Smith et al., 2015) and is characterised by deficits in executive function and spatial performance and delays in math and language (Kiblawi et al., 2014). The following are some of the personality and cognitive

disabilities of methamphetamine-exposed children identified by the teachers: “delayed physical, academic and social development is noticeable, memory loss, in some cases no memory, children need constant and consistent re-teaching and repeating of instructions or information, i.e. not processing information, poor or lack of motivation, most children are academically poor - under average, lack a concept of time and time management/no idea of time, seem lazy and do not know how to complete tasks given, some children cannot recognise sounds - cannot put words/sentences together and most of the children show a very basic understanding of mathematics” (Haefele, 2012, p. 63). Since MM use influences children’s cognitive development, it is evident how it impacts children’s school readiness. Consequently, affecting on adequate development during ECD

6.2.1.3 Maternal methamphetamine (MM) use and ECD

The influence that MM use has on cognitive development, which leads to learning disabilities and/or difficulties, has an impact on the child’s school readiness, thus impacting adequate development during ECD. Early childhood development are “programmes that cater to the physical, cognitive, and social-emotional development of a child from conception up until the age of six” (Hayashi et al., 2022, p. 5). There are volumetric reductions in the caudate nucleus in preschool children prenatally exposed to MA, suggesting the caudate nucleus impacts cognitive control processes (Smith et al., 2015). Therefore, adequate early childhood development is paramount for children’s future success. The relationship between prenatal methamphetamine exposure, early childhood adversity and subsequent childhood neurodevelopment was associated with deficits in executive function at age 6.5 and demonstrated that the effects of MA on neurodevelopment functioned primarily through early adversity (Smith et al., 2015). Educators noted that children exposed to MA need special schooling when they move to mainstream schooling if they do not get timely assistance during their ECD phase (Haefele, 2012). The children will thus have difficulty transitioning from ECD

to mainstream schooling and thus impact poor school performance. The findings in the sub-themes have indicated the influence of MM use on the cognitive development and school readiness of children in ECD.

6.3 Refutational synthesis

The refutational synthesis attempt to reconcile contradictions between identified themes/concepts (Noblit & Hare, 1988). During this stage of the analysis, themes that come to opposite conclusions to the main body of work of the included studies. One refutational theme was identified in the included studies, which is discussed below:

6.3.1 The timing of MA exposure influences the outcomes

Appropriate literature has firmly indicated that MM use has an impact on the cognitive development and school readiness of children in ECD (Abar et al., 2013; Chakraborty et al., 2015; Gorman et al., 2014; Haefele, 2012; Haefele, 2011; Prinsloo & Ovens, 2018; Shah et al., 2012). However, the findings of the included studies (Kiblawi et al., 2014; Smith et al., 2015; Smith et al., 2011) indicated that it is unable to determine the direct toxic effects of MA versus the multiple risk factors associated with drug use during pregnancy (Smith et al., 2015), also suggesting that there were no clear effects of prenatal MA exposure on child development clearly defined. Smith et al. (2011) suggest that children are affected modestly by MM, and those heavily exposed children have poorer cognitive and motor performance. MA exposure during the first trimester compared to the third trimester could have a different impact on the developing child (Smith et al., 2015). No significant main effects of MA exposure in children were observed, and significant interactions between exposure and time of exposure were found (Kiblawi et al., 2014). It was suggested that the timing of MA use and exposure influence the type of outcome in children. No differences were observed between MA-exposed and non-exposed regarding the effect on their central nervous system or signs of drug withdrawal (Smith et al., 2015). However, the included studies that contradict the main themes of the current study

have either done a short study (Kiblawi et al., 2014) on the effect of MM and how it impacts children's development or the study only focused on self-reporting participants that might not be heavily depended on MA (Smith et al., 2015; Smith et al., 2011) and therefore, might produce bias results.

6.4 Line of argument synthesis

The line of argument synthesis is the development of a general interpretation of the phenomena of interest grounded in the themes and concepts of each study (Noblit & Hare, 1988). During this stage of the analysis, a statement that can be summarised and express what has been found is presented within the current study. First, the prevalence of maternal methamphetamine remains a problem in society today and has an adverse effect on children exposed to maternal methamphetamine use. Second, MM use influences children's cognitive development, consequently affecting children's school readiness, thus impacting adequate development during ECD and resulting in poor school performance which prevents children from reaching their full potential. Third, MM use is a strong projecting factor for the influence on cognitive development and school readiness in ECD (Abar et al., 2013; Chakraborty et al., 2015; Gorman et al., 2014; Haefele, 2012; Haefele, 2011; Prinsloo & Ovens, 2018; Shah et al., 2012). Fourth, MM use directly impacts and influences children's cognitive development, causing cognitive impairment and affecting the child's school readiness. Therefore, hindering development during ECD, resulting in poor school performance once children enter into mainstream schooling. Finally, it is apparent from the included studies that maternal methamphetamine use is an individual, family and community issue.

6.5 Chapter Summary

Children are unfavourably affected by maternal methamphetamine use. MM influences and impacts children's cognitive development and school readiness, influencing their ECD experience. In order to try to eliminate the problem, education and awareness by professionals

is necessary for pregnant women, and early identification of MM-exposed children in ECD can contribute to understanding developmental causes in order to identify preventative approaches for children timeously.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

The aim of the current study was to examine and report on the impact of maternal methamphetamine ("*tik*") use on the cognitive development and school readiness of children in early childhood development. The study engaged in a systematic review methodology to address the study's aim and objectives. The systematic review methodology enables rigorous evaluation of key literature reporting on the impact of maternal methamphetamine ('*tik'*) use on children's cognitive development and school readiness in early childhood development (ECD). A systematic review also enables a combination of current research on maternal methamphetamine, which will provide an understanding of the impact and how to address the impact of maternal methamphetamine use on children.

The current study strived to answer the following research question: "*What is the impact of maternal methamphetamine use on the cognitive development and school readiness of children in early childhood development?*" Therefore, the objectives of the current study were: *to identify the effects of maternal methamphetamine (tik) use on the cognitive development of children in ECD, to identify the effects of maternal methamphetamine (tik) use on the school readiness of children in ECD* and *to appraise the methodological rigour of studies exploring the impact of maternal methamphetamine (tik) use on school readiness of children in ECD.*

A descriptive and theory explanation of the meta-synthesis was used to analyse the given study's findings. The descriptive meta-synthesis was employed to provide a descriptive account of the findings using data extraction sheets in order to extract the findings. The theory explanation meta-synthesis was used to analyse the findings and to interpret the themes that emerged from the findings of the current study. The theoretical framework, the bio-ecological

system of Bronfenbrenner, was used to illustrate the connection of theory to practice, and a relevant literature review was conducted in order to demonstrate and provide a better understanding of the impact of MM use on the cognitive development and school readiness of children in ECD. The present study provides the reader with an executive summary which outlines how the study has met the aim and objectives of the study using a systematic review methodology. In addition, the significance of the study is discussed, along with the limitations of the study. Lastly, the recommendations section provides recommendations for future studies, research and early interventions for children impacted by maternal methamphetamine use.

7.2 Executive Summary

Methamphetamine (MA) is a pressing concern worldwide, but what is even more concerning is maternal methamphetamine (MM) use. MM use impacts children's cognition, therefore, affecting their development. MA-exposed children encounter various challenges caused by the MA prevalence and its impact/effects on child development. The impact/effects of these challenges in the lives of MA-exposed children have become a concern to scholars in various disciplines. There are studies available on the effects of prenatal MA-exposed children, yet only limited existing studies have endeavoured to understand how those effects influence children's school readiness. Even fewer studies aim to understand the relationship between MM and ECD and its outcomes on school performance. Therefore, leaving a gap in knowledge and data exploring the impact of MM use on children's cognitive development and school readiness in ECD. Thus, resulting in insufficient available literature addressing the prevalence of MM use on children and their development.

Development among MM-exposed children has been lower and slower compared to non-exposed children. In addition, several parental, environmental and social factors may contribute to even poorer cognitive functioning, increasing the child's inability to prepare for school

readiness in ECD. Therefore, MM use remains the fundamental difference between child development and non-exposed children. In order to explain this, the current study has focused on the influence and impact of MM use on child development and school performance. The current study appraised literature through a systematic review and methodological appraisal of studies published during 2010-2020, reporting and addressing the impact of MM use on cognitive development and school readiness in ECD. The methodological appraisal was conducted using the PRIMSA levels of review in four operational steps, namely; 1) identification of relevant studies for inclusion, 2) screening of abstracts of potential studies for eligibility, 3) evaluation of eligible studies for methodological quality using the appraisal tool for inclusion and 4) included studies following the process of data extraction and meta-synthesis.

The current study's findings have shown the presence of quality studies reporting on the impact of MM use on children's cognitive development and school readiness in ECD. The eleven included studies have effectively reached the predetermined threshold score (81%-100%). The findings of these included studies were extracted, tabularised descriptively and synthesised.

Based on the findings, the following objectives were achieved:

1. The study's first objective was *to identify the effects of maternal methamphetamine (tik) use on the cognitive development of children in ECD*. The findings suggest that MM-exposed children suffer from various cognitive abnormalities affecting their neurodevelopment. MM exposure on brain development may be detrimental to the development of the child due to the smaller subcortical volumes comprising the putamen, globus pallidus, and hippocampus of the brain, possibly impacting attention and memory. In addition, pre and postnatal MA exposure frequently leads to development delays, particularly in speech and language skills. As a result, children may not meet development

milestones and may lack basic socialization skills. Therefore, identifying the effects of maternal methamphetamine (tik) use on the cognitive development of children in early childhood development (ECD).

2. The second objective of this study was *to identify the effects of maternal methamphetamine (tik) use on the school readiness of children in ECD*. The findings suggested that MM use influences cognitive abnormalities in children exposed to MM, causing learning disabilities and difficulties impacting their school readiness. Key features in MM-exposed children concerning school readiness, such as delayed academic development, poor memory and reading, writing and language comprehension. MM use impacts ECD experience as these effects are characterised by deficits in executive function and spatial performance and delays in math and language comprehension. The influence that MM use has on cognitive development, which leads to learning disabilities and/or difficulties, has an impact on the child's school readiness, thus impacting adequate development during ECD. Therefore, identifying the effects of maternal methamphetamine (tik) use on the school readiness of children in ECD.
3. The third and last objective was *to appraise the methodological rigour of studies exploring the impact of maternal methamphetamine (tik) use on school readiness of children in ECD.* The objective was attained in the eligibility level of review, the third level discussed in Chapter Four. Studies identified as eligible for inclusion were retrieved and methodologically appraised using a critical appraisal tool by two reviewers. Before adding any studies to the current study, the methodological rigour of all studies was appraised. From the systematic appraisal, eleven studies were appraised for methodological rigour of studies exploring the impact of MM use on children's school readiness in ECD.

7.3 Significance of the Study

The current study provided insight into the impact of MM use on children's cognitive development and school readiness in ECD. It provides needed information to address the identified issues in a systematic and rigorous manner while also outlining the limitations and gaps in existing research. The information from the current study may have a positive influence on future research and intervention strategies aimed at decreasing drug dependency, focusing on MM dependency. The findings and information provide knowledge that will contribute to the welfare of children affected by maternal methamphetamine, which can be used to develop and restructure policies and intervention programmes to cater to the needs of the children in ECD. This will allow children the chance and ability to be able to reach their full potential developmentally.

7.4 Limitations of the Study

Language bias, as well as publication bias, was present in the current study. Language bias occurred as applicable studies in other languages were omitted, limiting the sample frame of inclusion of studies. Therefore, searches for eligible studies on the databases were limited to English-medium studies. Publication bias occurred as published studies are limited to specific requirements of journals, which tends to omit specific methodological information – resulting in a limited sampling frame of articles in order to identify potential titles.

Furthermore, three of the included studies reported the impact of MM use on cognitive development and school readiness. However, despite the valuable contribution that those studies made to the current study – these studies failed to place focus on the impact on ECD, resulting in not being able to establish the true relationship between MM use on ECD and in that losing the quality of findings demonstrating the impact of MM use on the cognitive development and school readiness of children in ECD.

Lastly, most studies did not include how long the mother used MA during pregnancy. Therefore, making it difficult to establish if the frequency of usage (length of time) affects the severity of the impact on the child's cognitive development and school readiness in ECD. What made it more challenging was that cases were self-reported by the mothers and limited, if any, toxicology screenings done on expecting mothers to give a true representation of the data on methamphetamine depended on mothers.

7.5 Recommendations

Drawing on the findings of the current study, the following recommendations are made:

- Given the findings, further and future research needs to focus on MM use and its association with school readiness and performance. Such research should ruminate the various ways in which MM impacts on children's ability to prepare for school readiness which ultimately, as indicated by the current study, effects children's cognitive and academic performance.
- A need for future research on MM use on the cognitive development and school readiness of children ECD in the South African context in order to develop culturally appropriate interventions. Most of the studies concentrate on the Western context of children exposed to MM. South Africa is a diverse country therefore, future studies need to consider the language, traditions, beliefs, customs and values for successful implementation of culturally appropriate intervention in order to relate to the Southern African experience of MM use.
- Many of the literature were based on self-reported cases. Studies were unable to report on the level of dependency of the expecting mother. Therefore, future research needs to determine whether the impact of MM use depends on when the mother used it during pregnancy and how often (level of dependency). This can be done in collaboration with the health care sector and welfare sector, toxicology screening needs to be done on all

suspected dug dependant mothers and referred to the welfare sector i.e. Social Workers. This will allow social workers to refer expecting mothers for treatment, interventions and provide them with the needed resources to become drug free and the ability to understand the impact their dependency has on their children.

- Understanding the effect of prenatal exposure to MA on the developing child is important. Therefore, appropriate support structures and programmes need to be developed to assist children in reaching their full potential cognitively, academically and emotionally in the ECD phase. There needs to be an availability of support structure such as pre and post natal programs and intervention – educating parents on nurturing care and the cognitive effects of MM, support groups and home visits.
- Majority of the literature and proposed interventions focus on the drug dependent mother, more interventions should be developed and be inclusive of the father. Most partners use drugs together therefore, interventions need to reflect equality as the child's well-being are both parents responsibility.
- Stronger linkages need to happen between parents, early childhood educators and early interventions in order to work in partnership to identify and assess children with a delays in learning so they are given the opportunity to have a smooth transition from ECD into mainstream schooling.
- Additionally, the development of different policies and early intervention programmes aimed at assisting MM-dependent mothers and protecting the well-being of innocent children especially for those in low to medium-income household. Sterner policies need to be put into place for pregnant drug dependent mothers, a drug depend household and the reporting of drug dependent mothers. As some countries in the West, which has spark heated debates, on whether drug use and abuse during pregnancy should be seen as a criminal offence.

- There needs to be more awareness of children born from mothers who use methamphetamine during pregnancy and its lifelong effects on children. This can be implemented as a prenatal intervention made available at government and non-governmental level to make it accessible to all, especially the disadvantage communities (low to medium-income) as financial limitations and a lack of resources are a risk factor to MM use and abuse.
- Based on the findings, MA-exposed children have an absence of the following services that may act as protecting factors for them; lack of adequate access to education that cater to their needs, a stable support system, legal protection and quality medical care.

7.6 Chapter Summary

This chapter focuses on the conclusion of this study, which describes how the aim and objectives of the current study were met. The chapter commences by providing an executive summary of the current study, it is followed by stating the significance of the study. Towards the end of the chapter, the limitations and recommendations for future research are discussed.

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Appendix A: List of Databases

Natural Sciences	Social Science	Education & Health
BioMed Central	African Development Indicators	Academic Search Complete
BioOne	The African Journal Archive	EbscoHost Web
Health Source: Consumer Edition	AnthroSource	Emerald eJournal Premier
Health Source: Nursing Edition	Cambridge Journal Online	MasterFile Premier
Medline (Pubmed)	CINAHL	SA ePublications
Medline (EbscoHost)	JSTOR	Wiley Online Library
PubMed	Nexus	
ScienceDirect	Oxford Journals Online	
SCOPUS	PsychARTICLES	
	Sabinet African Journal Archive	
	Sage Journal Online	
	SocIndex	

Appendix B: Title Summary Sheet

Author	Date	Title and Source	Database	Location Stored	Outcome (inclusion/exclusion)

Appendix C: Abstract summary sheet

Author	Type of study design	Study population	Instrument/s used	Outcome	Results of study analysis/ Quality of results

Appendix D: Critical Appraisal Tool for Qualitative Studies

Critical Appraisal Tool for Qualitative Studies **Reviewer: _____ Author: _____** **Title: _____ Year: _____**		
Study Purpose	**Yes (1)**	**No (0)**
1. **Has an extensive literature review been conducted to inform the context and background of the study?** 2. **Is the problem statement been made explicit?** 3. **Is a clear rationale for the study provided?** 4. **Have the Aims been clearly stated?** 5. **Are the objectives clearly stated?** 6. **Are the aims and objectives explicitly linked to the research question?** **Total:**		
Study Design	**Yes (1)**	**No (0)**
1. **Does the article seem to explore/interpret the subjective experiences of participants?** 2. **Is the methodology suitable for the proposed objectives?** 3. **Does the research design address the aims and objectives of the study?** 4. **Did the authors indicate the reasoning for the methodology?** 5. **Is a theoretical framework or underpinning identified?** **Total:**		
Sampling	**Yes (1)**	**No (0)**

1.	Is the source population identified?		
2.	Is there a clear distinction between probability and non-probability sampling?		
3.	Is the sampling method appropriate?		
4.	Did the author/s motivate their sample choice?		
5.	Are inclusion and exclusion criteria clearly stipulated?		
6.	Is the sample representative of the population?		
7.	Has informed consent been obtained from participants?		

Total:			
Data Collection		**Yes (1)**	**No (0)**
1.	Is data collected in an ethically sound manner?		
2.	Is the setting of data collection noted?		
3.	Did the authors explicitly indicate the method of data collection (e.g. interviews, Focus groups, etc.)?		
4.	Are these methods of data collection appropriate?		
5.	Were any methods modified during the course of the study?		
6.	Is the form of data clear (notes, tape-recordings, etc.)?		
Total:			
Data Analysis		**Yes (1)**	**No (0)**
1.	Is the Method of data analysis clearly stipulated?		
2.	Did the author provide an in-depth description of the process of analysis?		
3.	Is there sufficient data to support the findings?		
4.	Was contradictory data accounted for?		
5.	Has the Author/s accounted for bias and influence?		
Total:			

Findings	**Yes (1)**	**No (0)**
1. **Are the findings made explicit?** **Is there adequate evidence to support the findings?** **2.** **3.** **Has the researcher discussed the credibility of findings (e.g. triangulation, another analyst, respondent validation)?** **4.** **Are findings linked to the research question?** **5.** **Are findings generalizable?** **Total:**		
Conclusion	**Yes (1)**	**No (0)**
1. **Is the conclusion clear?** **2.** **Is the conclusion supported by the findings?** **3.** **Are appropriate recommendations made?** **4.** **Are limitations explicitly identified?**		
Total:		
Ethical Considerations	**Yes (1)**	**No (0)**
1. **Is ethical approval obtained from an identifiable committee?** **2.** **Did the Author/s report of gaining access from appropriate institutions?** **Have these ethical issues been reported on:** **3.** **Confidentiality?** **Anonymity?** **Withdrawal?** **Total:**		

Total Score/ Percentage **Weak (0-30%)** **Moderate (31-65%)** **Strong (66-80%)** **Excellent (81-100%)** **(Studies below the threshold stipulated in the category strong shall be excluded. In addition, studies not focusing on the impact of maternal methamphetamine ('tik') use on the cognitive development and school readiness of children in early childhood development shall be excluded.)**	**Score (/41)**	**%**
Overall Outcome: Include □ Exclude □ Seek Further Info□		

Appendix E: Critical Appraisal Tool for Quantitative Studies

Critical Appraisal Tool for Quantitative Studies **Reviewer: _____ Author: _____** **Title: _____ Year: _____**		
Study Purpose	**Yes (1)**	**No (0)**
1. Is the problem statement been made explicit? **2. Is a clear rationale for the study provided?** **3. Have the Aims been clearly stated?** **4. Are the objectives clearly stated?** **5. Are the objectives clearly stated?** **6. Are the aims and objectives explicitly linked to the research question?** **Total:**		
Literature Review		
1. Has an extensive literature review been conducted to inform the context and background of the study? **2. Are gaps in the literature identified?** **3. Is the need for further research addressed?** **Total:**		
Study Design	**Yes (1)**	**No (0)**

1. Is the research design identified (e.g. RCT, Cohort design, case study, cross-selection, etc.)? 2. Are the essential features of the design stipulated? 3. Is the study design appropriate? 4. Have the author/s indicated the reasoning for their design selection? 5. Does the research design address the aims and objectives of the study? **Total:**		
Sampling	**Yes (1)**	**No (0)**

1. Is the source population identified? 2. Is there a clear distinction between probability and non-probability sampling? 3. Did the author/s motivate their sample choice? 4. Is the sampling method appropriate? 5. Is the sample representative of the population? 6. Is the sampling size justified? 7. Has informed consent been obtained from participants? **Total:**		
Outcomes	**Yes (1)**	**No (0)**

1. Were the instruments used clearly identified with references? 2. Are these instruments appropriate? 3. Were steps taken to ensure the reliability of outcome measures? 4. Did the Author/s account for: Sample bias? Measurement bias? Performance bias 5. Which psychometric properties were reported on: Did they report on psychometric properties? Psychometric properties on the scale of the sample? Type of data produced by instrument? Did the data produced support the proposed analysis? **Total:**		
Findings	**Yes (1)**	**No (0)**
1. Is the statistical significance of the results indicated? 2. Is such statistical significance justified? 3. Are analysis methods appropriate? 4. Are results correctly interpreted in relation to the research question? **Total:**		
Conclusion	**Yes (1)**	**No (0)**
1. Is the conclusion clear? 2. Is the conclusion supported by the findings? 3. Are appropriate recommendations made?		
4. Are limitations explicitly identified? **Total:**		
Ethical Considerations	**Yes (1)**	**No (0)**
1. Is ethical approval obtained from an identifiable committee?		

2.	**Did the Author/s report of gaining access from appropriate institutions?**		
3.	**Have these ethical issues been reported on:** **Confidentiality?** **Anonymity?** **Withdrawal?**		
Total:			
Total Score/ Percentage **Weak (0-30%)** **Moderate (31-65%)** **Strong (66-80%)** **Excellent (81-100%)** **(Studies below the threshold stipulated in the category strong shall be excluded. In addition, studies not focusing on the impact of maternal methamphetamine ('tik') use on the cognitive development and school readiness of children in early childhood development shall be excluded.)**		**Score (/45)**	**%**
Overall Outcome: Include □ Exclude □ Seek Further Info□			

Appendix F: Critical Appraisal Tool for Mix Method Studies

Critical Appraisal Tool for Mixed Method Studies **Reviewer: _____ Author: _____** **Title: _____ Year: _____**		
Study Purpose	**Yes (1)**	**No (0)**
1. Is the problem statement made explicit? **2. Is a clear rationale for the study provided?** **3. Have the aims been clearly stated?** **4. Are the objectives clearly stated?** **5. Are the aims and objectives explicitly linked to the research question?** **Total:**		
Literature Review		
1. Has an extensive literature review been conducted to inform the context and background of the study? **2. Has a theoretical framework been identified?** **3. Are gaps in the literature identified?** **4. Is the need for further research addressed?** **Total:**		
Study Design	**Yes (1)**	**No (0)**
1. Is the research design clearly identified (e.g. RCT, cohort design, case study, grounded action theory, etc.)? **2. Are the essential features of the design stipulated?** **3. Has the author/s indicated reasoning for their design selection?** **4. Does the research design address the aims and objectives of the study?** **Total:**		
Sampling	**Yes (1)**	**No (0)**

1. Is the source population identified? 2. Is the method of sampling clearly identified? 3. Are the inclusion and exclusion criteria explicitly identified?		

4. Is the sampling method appropriate for the aims and objectives outlined in the study? 5. Is the sample representative of the population? 6. Is the sampling size justified? **Total:**		
Outcomes	**Yes (1)**	**No (0)**
1. Were the instruments used clearly identified? 2. Are these instruments appropriate? 3. Were steps taken to ensure the reliability of outcome measures? 4. Did the author/s account for potential bias? 5. Has the researcher accounted for their role in the current study? 6. Were psychometric properties reported on (scale of sample, data produced by instruments, etc.? **Total:**		
Findings	**Yes (1)**	**No (0)**
1. Are the results clearly stipulated? 2. Are outcomes justified by adequate findings (both statistical and descriptive findings)? 3. Are methods of analysis appropriate? 4. Are results correctly interpreted in relation to the research question? 5. Are qualitative and quantitative results integrated? **Total:**		
Conclusion	**Yes (1)**	**No (0)**

1. **Is the conclusion clear?** 2. **Is the conclusion supported by the findings?** 3. **Are appropriate recommendations made?** 4. **Are limitations explicitly identified?** **Total:**		
Ethical Considerations	**Yes (1)**	**No (0)**
1. **Was ethical approval obtained from an identifiable committee?** 2. **Did the author/s report on gaining access from appropriate institutions?** 3. **Have the following ethical issues been reported:**		
Informed consent **Confidentiality** **Anonymity** **Withdrawal** **Total:**		
Total Score/Percentage 6. **Weak (0–30%)** 7. **Moderate (31%–65%)** 8. **Strong (66%–80%)** 9. **Excellent (81%–100%)** **(Studies below the threshold stipulated in the category strong shall be excluded. In addition, studies not focusing on the impact of maternal methamphetamine ('tik') use on the cognitive development and school readiness of children in early childhood development shall be excluded.)**	**Score (/41)**	**%**
Overall Outcome: Include ☐ Exclude ☐ Seek Further Info ☐		

Appendix G: Data Extraction Sheets

Author	General Description			
	Target population	*Demographic Variables*	*Geographic Location*	*Aim/problem statement*

Author	Methodology				
	Study Design	*Theoretical underpinning*	*Sampling method*	*Sample size*	*Data collection method/instrument*

Author	Findings and Analysis			
	Results, Evidence, Findings	*Conclusion*	*Recommendations*	*Limitations of Study*

Appendix H: Ethical Clearance letter

UNIVERSITY of the
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20 November 2018

Ms A Willemse
Child and Family Studies
Faculty of Community and Health Science

Ethics Reference Number: BM18/8/3

Project Title: Impact of maternal methamphetamine ('tik') use on the cognitive development and school readiness of children in early childhood development: a systematic review.

Approval Period: 19 October 2018 – 19 October 2019

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

Res The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
arch Ethics Committee Officer
University of the Western Cape

CONFIRMATION OF EDITING: Abigail Willemse

19 July 2023

To whom it may concern

This letter serves to indicate that we at the Student Development Centre, reviewed and provided editorial feedback for the Masters Thesis of Ms Abigail Willemse. We have successfully done editing and formatting for over 60 postgraduate student theses, and attended various webinars on formatting and referencing.

We completed a language, format and referencing edit of the abovementioned author's thesis.

The nature of the editorial review was to provide feedback on:
- Sentence construction as it relates to the clarity of expression and style;
- Accuracy of grammar, tense related editing and punctuation;
- APA as it relates to both referencing (both in-text and full-citations) and format;
- Thesis format editing according to the typical thesis formats accepted.

Utilising the review functionality tools ('track-changes' and 'comments') in Microsoft Word, the author was requested to review and attend to changes that were deemed appropriate for the improvement of the text. The overall accuracy and quality of the document remains the author's responsibility.

Please do not hesitate to contact me should you have any further questions.

Warm Regards
Jill Masters
Director of Student Development Centre
admin@studentdevelopmentcentre.com