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Title: Effect of the consumption of a hypoproteic diet in pregnancy on brain and behavioral disorders in the postnatal stage

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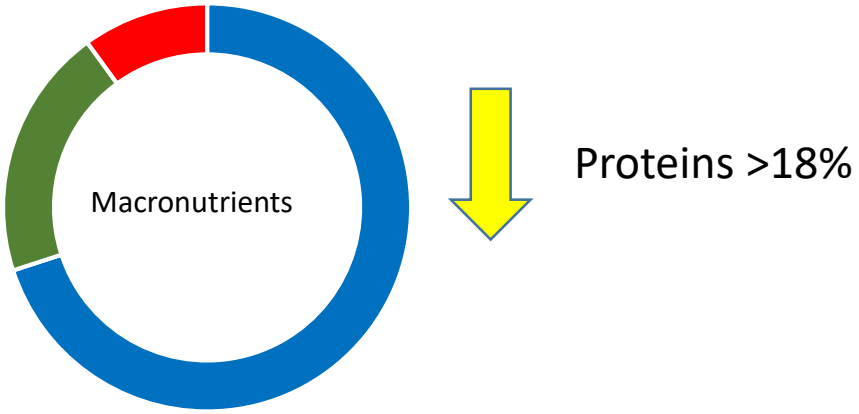
INTRODUCTION

It is known that an adequate protein intake during pregnancy should be in a proportion of 18-20% of total macronutrients (Sellayah & Cagampang, 2018).

Low-protein diet consumed during pregnancy indicates a negative impact on the maternal environment and the offspring health (Langley-Evans et al., 1996; Rees et al., 2000; Zambrano et al., 2006).



The consumption of low-protein diets during pregnancy produces changes in body weight, blood pressure, sugar and fat metabolism, intake, adiposity, in the maternal environment as well as progeny (Langley-Evans et al., 1996; Rees et al., 2000).

In humans, it has been shown that the offspring of those mothers who consumed a low-protein diet during pregnancy have a lower body weight compared to the offspring of mothers who consumed a higher proportion of protein (Waksmańska et al., 2020).

In the postnatal stage, the risk of developing metabolic syndrome increases due to the intake of a low-protein diet during pregnancy (Moore et al., 2004).

METHODOLOGY

The search was limited to indexed articles published in the period from 1994 to 2021.

Exclusion criteria: consensus, position papers, reviews and articles reporting a meta-analysis.

The search was conducted in May and June 2021.

PubMed.gov

RESULTS

Twenty-two original research articles published in international journals were selected.

Morphological and functional alterations
9 articles
100 % murine models
88.9 % comparison between control and and experimental group

Behavioral alterations
13 articles
100 % murine models
100 % comparison between control and experimental group

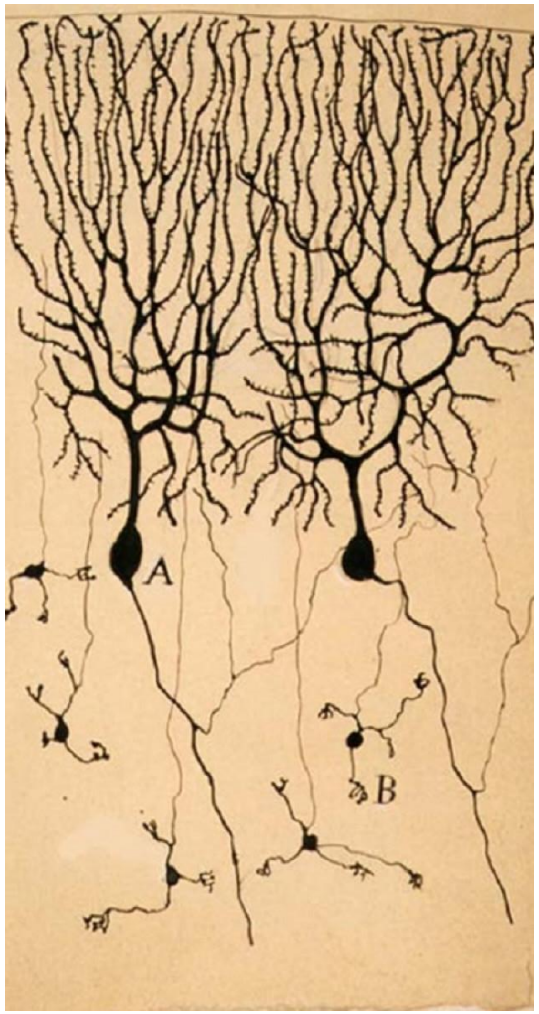
MORPHOLOGICAL AND FUNCTIONAL ALTERATIONS

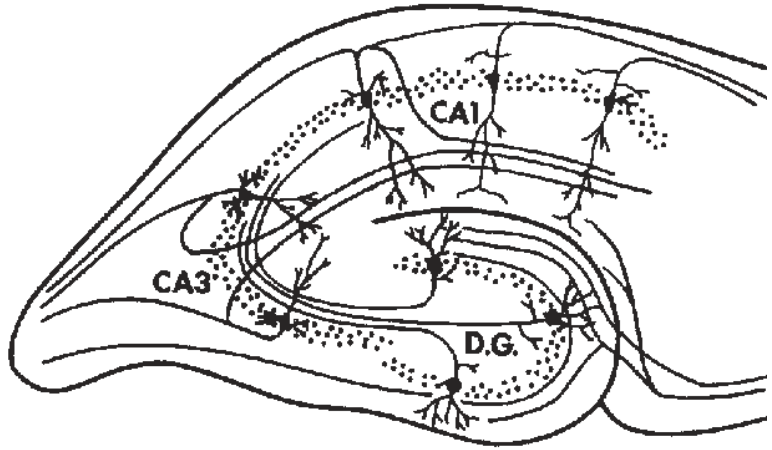
Decreased population of granular and pyramidal cells in the hippocampus at PND 30

(Debassio et al., 1994).

Decreased population of granular and pyramidal cells in the hippocampus at PND 90

(Debassio et al., 1996).





Decreased cerebral cortical thickness (E15).

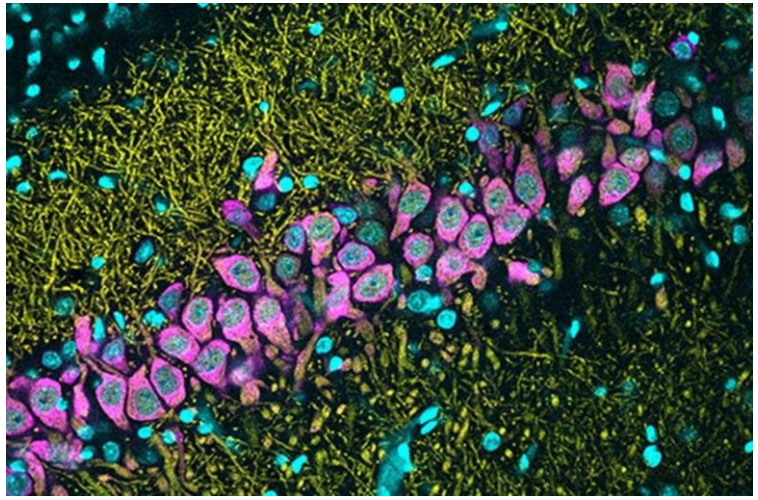
Delayed astrocytogenesis, decreased apoptosis, neural differentiation and abnormal synaptogenesis. (DPN 0, 7 and 14)

(Gressens et al., 1997).

PND= Postnatal Day E= Embryonic Day

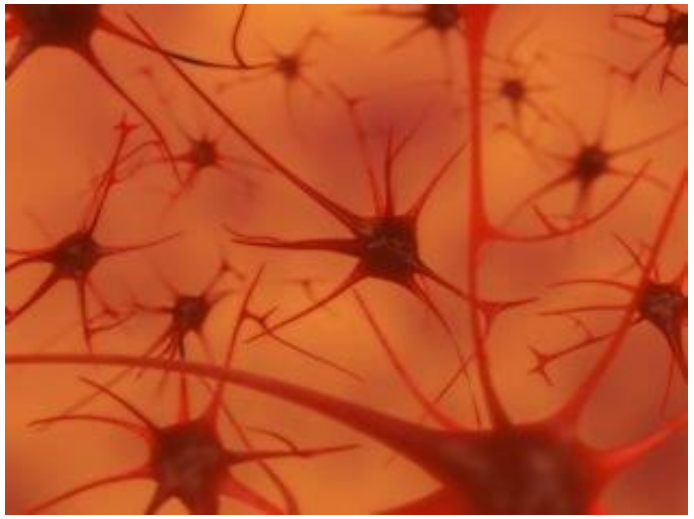
Deficits in total rostro-caudal extent and volume of the hippocampal mossy fiber plexus at PND 15, 30, 90 and 220.
(Cintra et al., 1997).

Changes in glia of the cerebral cortex, hippocampus and cerebellum due to increased GFAP, S100B and GS.
(Feoli et al., 2008).



↓ Adiponectin

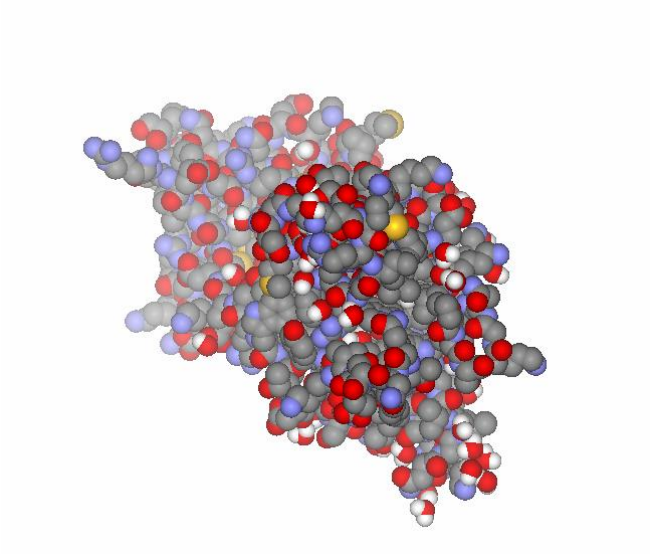
↑ Osteopontine, MCSF1, y VCAM 1
PND 82 – 86
(Guest et al., 2012)



GFAP= Glial Fibrillary Acidic Protein S100B= S100 Calcium Binding Protein GS=Glutamyne Synthethase
MCSF1= Macrophage Colony Stimulating Factor VCAM-1= Vascular Cell Adhesion Protein 1

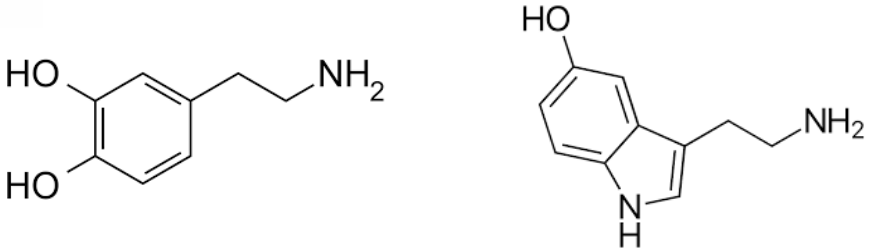
Decrease in BDNF expression at PND 0.1

(Marwarha et al., 2017).



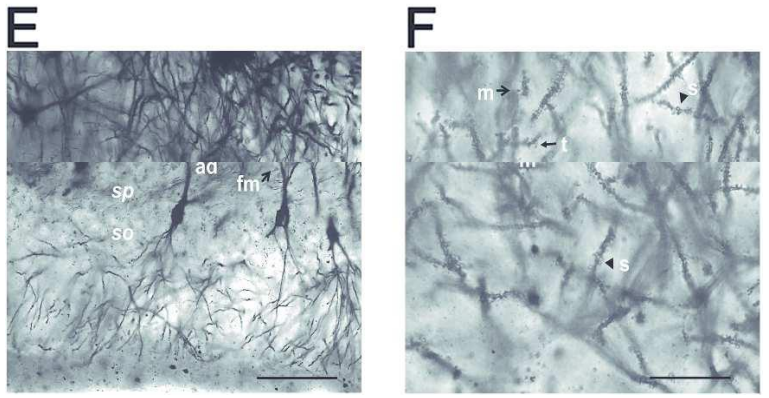
Altered concentration of neurotransmitters dopamine and serotonin

(Abey et al., 2019).



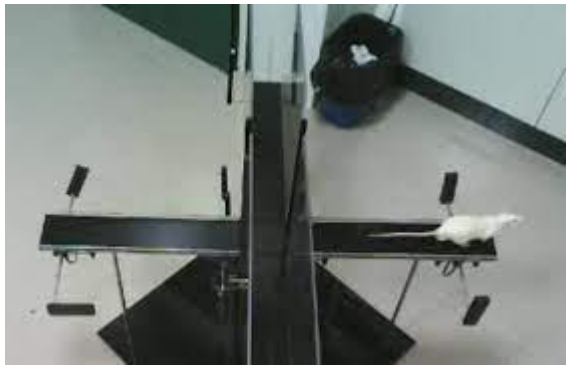
Decreased spines in mossy fibers and increased immature spines in the hippocampus at PND 110

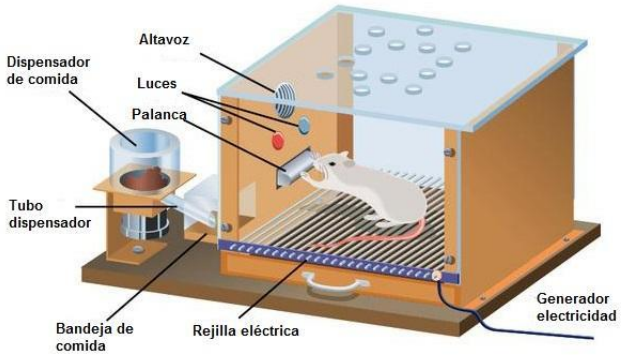
(Reyes-Castro et al., 2018).



BDNF= Brain-derived Neurotrophic Factor

BEHAVIORAL ALTERATIONS





Behavioral paradigm used:

- Elevated plus maze
- Operant conditioning
- Sucrose preference
- Reinforcement
- Others

The following results were found

Decreased anxiety response

Moment of hypoproteic diet administration: Preconception, gestation and lactation.

Offspring age in behavioral evaluation: PND70

(Almeida et al., 1996)

Decreased associative learning

Moment of hypoproteic diet administration: gestation and lactation

Offspring age in behavioral evaluation: PND120

(Reyes-Castro et al., 2011)

Increased anxiety and stress response

Moment of hypoproteic diet administration: gestation and lactation.

Offspring age in behavioral evaluation: PND90 - 95

(Reyes-Castro et al., 2012)

BEHAVIORAL ALTERATIONS

Gestation and lactation
Increased anxiety response (PND91-93).
Decrease in associative learning (PND110-135).
Decreased stimulus responses (PND135-146).

(Reyes-Castro et al., 2012)

Gestation
Learning impairment (PND41, 64, 96).

(Gould et al., 2017)

Mating, gestation and lactation
Impaired righting reflex (PND2-10).
Decreased auditory startle (PND14 - 18).
Decreased sniffing behavior, decreased escape attempts and motor activity, increased anxiety response and immobility time (PND22 - 26).

(Belluscio et al., 2014)

Gestation
- Increased ultrasonic vocalizations (PND5).
- Decreased avoidance responses (PND63).

(Batista et al., 2017)

Gestation and lactation
Impaired learning and memory (PND110).

(Reyes-Castro et al., 2018)

BEHAVIORAL ALTERATIONS

Gestation and lactations

- Decreased ultrasonic vocalizations (PND5).
- Decreased time spent in the nest (PND13).
- Decreased anxiety response and social interaction, as well as impaired learning and memory (PND30 - 32).

(Batista et al., 2019)

Preconception, gestation and lactation

- Decreased sensorimotor skills.
- Abnormal stereotyped behavior.
- Decreased anxiety response.
- Increased behavior towards light.
- Impaired aversive learning and spatial learning.
- Decreased sucrose preference.

- *All were measured at PND90, 180 and 360.(Sinha et al., 2020)

CONCLUSIONS

✓Adequate protein intake during pregnancy is involved in optimal functions such as development, CNS formation and intermediary metabolism.

✓Impaired morphology and functional mechanisms in the offspring's brains have been reported to be reflected in nesting behavior, motor behaviors, cognitive functions such as learning and memory as well as anxiety and stress responses.

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