

Developing Kangaroo Mother Care

From an Alternative Care Model to a Standard of Neonatal Care and Neuroprotection



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October 2026
Neuro-Protection Conference 2026
Bucharest, Romania



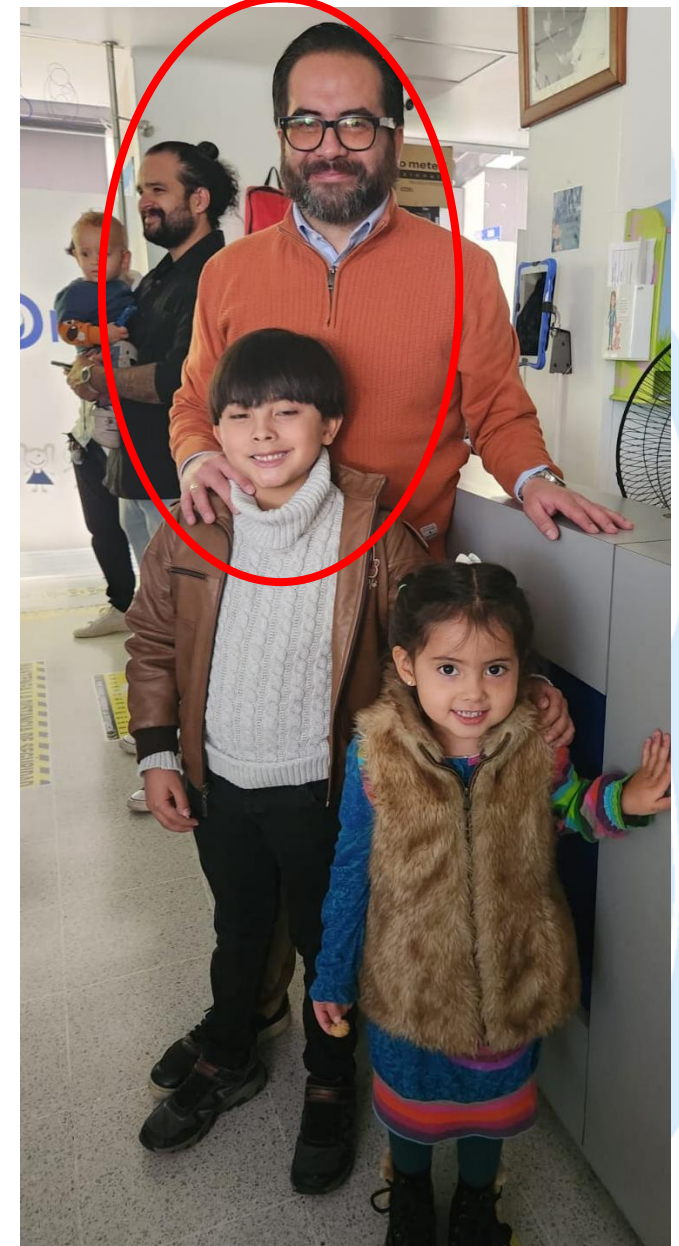
The **CHALLENGE**: How can we ensure an effective and cost-efficient high-risk follow-up for all preterm or low-birth-weight infants?

The **ANSWER**: the Colombian Kangaroo Mother Program.



1. Origins and core components of Kangaroo Mother Care (KMC) as an alternative to standard neonatal care.
2. Scientific, clinical and public health evolution of KMC from the original method to a globally evidence-based recommended standard of care in Colombia and worldwide.
3. Exploratory results supporting the impact of KMC on brain growth and neurodevelopment

1. Origins and core components of KMC as an alternative to standard neonatal care in 2026.



The Beginning: 1978



Kangaroo Mother Care method was created by Dr. Edgar Rey Sanabria in 1978, at the Instituto Materno Infantil (IMI) in Bogotá, and later developed by Dr. Martinez (1979-2021) and Dr. Navarrete (1982-1994).



Resistances and barriers in 1989

- The method is not technological, is “folkloric” and not evaluated.
- It involves extra work for the health personnel
- Not enough space in the neonatology unit for mothers and families
- Culturally, the role of the Kangaroo father is questioned.
- Difficulties are encountered with breastfeeding the premature infant.



What is KMC in 2026?

3 components : Kangaroo position, Kangaroo nutrition and early home discharge in kangaroo position with close monitoring up to 40 weeks and high risk follow-up up to 12 months of corrected age in a KMC Program

Target population
All premature (<37w)
and Low Birth Weight
Newborns (<2500g)

Kangaroo position initiated as **SOON** as possible and for as **LONG** as possible in the hospital and will continue at home after discharge



Where and when to initiate?



1-Kangaroo position in the delivery room



2-Kangaroo position in the NICU

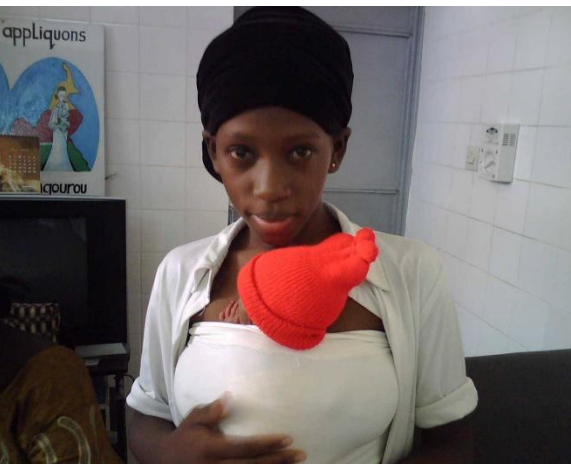


3 -Kangaroo position in the NICU



4-Kangaroo position in the
obstetric ward

Lycra band to support KMC



When to initiate?

The NEW ENGLAND JOURNAL of MEDICINE

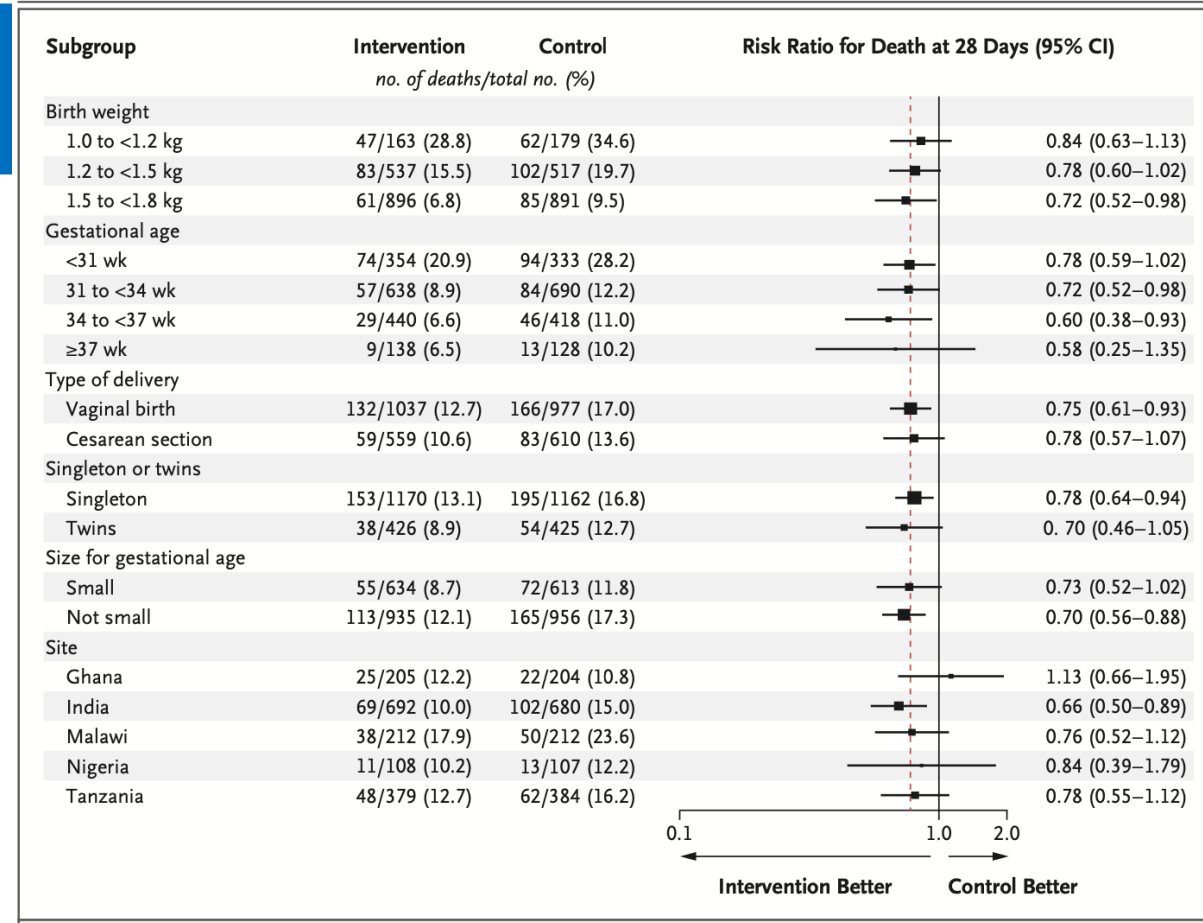
ORIGINAL ARTICLE

Immediate “Kangaroo Mother Care” and Survival of Infants with Low Birth Weight

WHO Immediate KMC Study Group*

CONCLUSIONS

Among infants with a birth weight between 1.0 and 1.799 kg, those who received immediate kangaroo mother care had lower mortality at 28 days than those who received conventional care with kangaroo mother care initiated after stabilization; the between-group difference favoring immediate kangaroo mother care at 72 hours was not significant. (Funded by the Bill and Melinda Gates Foundation; Australian New Zealand Clinical Trials Registry number, ACTRN12618001880235; Clinical Trials Registry-India number, CTRI/2018/08/015369.)



Newly born low birthweight infants stabilise better with skin contact than when separated from their mothers: a randomised controlled trial

Kim Chi Luong, Tien Long Nguyen, Duy Huong Huynh Thi, Henri P.O. Carrara, Nils K. J. B. ...

First published: 25 August 2015 | <https://doi.org/10.1111/apa.13164> | Cited by 123

Immediate Kangaroo Mother Care in a Cohort of Low-Birth-Weight Infants (Less Than 1800 g) in Vietnam

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Advances in neonatal care have improved survival rates for low-birthweight infants, but morbidity and poor quality of life persist, especially in low-income and middle-income countries. Simple, effective interventions are essential to reduce neonatal mortality and improve outcomes. Kangaroo-Mother care (KMC), which was developed in Colombia in 1978, comprises skin-to-skin contact in the Kangaroo position, exclusive breastfeeding and early discharge with follow-up. Vietnam has practiced KMC after stabilisation since 1996 [1].

In 2022, the World Health Organization endorsed KMC as a new global standard and recommends that it begins within minutes of birth, even before stabilisation [2]. Our study assessed the impact of immediate KMC (iKMC) on morbidity, costs and mortal-

ity. The study was conducted in a cohort of low-birthweight infants in Vietnam. The Kangaroo position continued during recovery, with monitoring and breast-feeding support.

Data were analysed with Stata 18 (Timberlake Group, London, UK). Outcomes were stratified by weight up to 999 g and 1000 to 1799 g. Primary outcomes included duration in the Kangaroo position, parenteral nutrition, number of days on antibiotics, feeding status at discharge, length of stay, mortality and costs.

We analysed 151/165 eligible infants: 26 up to 999 g and 125 from 1000 to 1499 g. All the families provided consent and iKMC was initiated a median of 2 min after birth, with infants in the Kangaroo position for 20–24 h a day during hospitalisation.

Newborns had better extrauterine adaptation..

In the continuous Kangaroo position group, babies required less respiratory support, less intravenous fluids and antibiotics during their hospital stay.

Conclusion 2015

Direct skin-to-skin contact in kangaroo position is the optimal environment for newborns who are not critically ill and weigh between 1,500 and 2,500 grams at birth. By preventing instability that requires additional medical treatment, KMC can save lives in low- and middle-income countries.



Delivery room skin-to-skin (DR-SSC) Sweden and Norway

Received: 4 October 2023

Revised: 29 February 2024

Accepted: 1 March 2024

DOI: 10.1111/apa.17200

BRIEF REPORT

ACTA PÆDIATRICA
NURTURING THE CHILD
WILEY

IPISTOSS study

Delivery room skin-to-skin contact for very preterm infants
promotes mother–child interaction and bonding

- Even in Swedish NICUs, where early and continuous SSC has strongly been promoted for decades, only 5% of infants with a gestational age <28 weeks had SSC on the first day of life.
- For term or moderate/late preterm infants early SSC, defined as within 180 min after birth was associated with **beneficial effects regarding parenting such as improved interaction and higher maternal satisfaction**.
- Our research demonstrated the **safety and benefit of DR-SSC for infants >25 weeks of gestation**.
- DR-SSC is a **team effort** and successful implementation requires close collaboration of the experts caring for both, the neonate and the mother.

Recent studies, including the multicentric one funded by the WHO, explored immediate post-birth KMC for “not stable”small, immature infants.

- WHO Immediate KMC Study Group. "Immediate “Kangaroo Mother Care” and Survival of Infants with Low Birth Weight." *New England Journal of Medicine* 384.21 (2021): 2028-2038.
- Brotherton, Helen, et al. "Impact of early kangaroo mother care versus standard care on survival of mild-moderately unstable neonates< 2000 grams: A randomised controlled trial." *EClinicalMedicine* 39 (2021): 101050.
- Klemming, Stina, Siri Lilliesköld, and Björn Westrup. "Mother-Newborn Couplet Care from theory to practice to ensure zero separation for all newborns." *Acta Paediatrica* (2021).

Immediate KMC (iKMC): Survival & Clinical Efficacy

2022 WHO New Standard of Care

- iKMC initiated within minutes of birth
- Even before full clinical stabilization
- "Strong recommendation, high-certainty evidence"
- Continuous, 24h/day, in hospital and at home
- Reduces hospital stay by ~10 days

Vietnam iKMC Study — Acta Paediatrica 2026

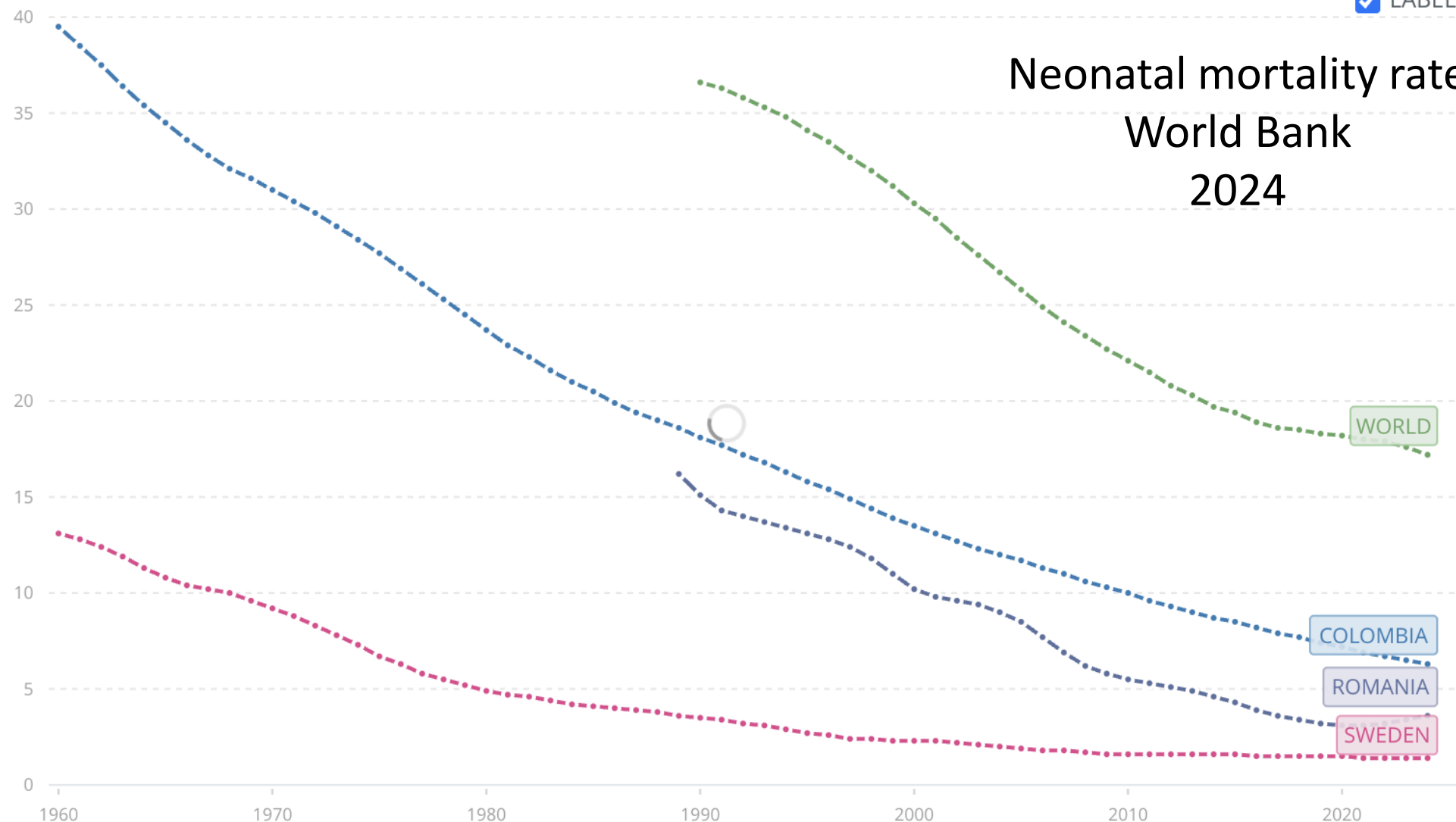
- 151 LBW infants (<1800g), iKMC within 2 min of birth
- 20–24h/day Kangaroo position during hospitalization
- Overall mortality 7.3% vs. 19.6% in a comparable hospital
- Feasible, safe, with strong family & staff engagement

↓25% neonatal mortality
with iKMC vs. waiting for stabilization

↓32% risk of neonatal sepsis
(transfer of protective maternal microbiota)

↓24% risk of postpartum depression
in mothers who practice KMC

Neonatal mortality rate World Bank 2024



18/1000

6/1000

3/1000

1/1000

1960 - 2024



New Vision for all!

Zero Separation
Always Together

Keeping the
family together

Infant- and Family-Centered
Developmental Care
from birth

Courtesy Stina Klemming, klemming.stina@gmail.com



Photo: Stina Klemming

Carl, GA w31+0, 1522 grams, 1000 sec = 16 minutes old

ImmEDIATE
PARENT
INFANT
SKIN
TO
SKIN
STUDY

IPISTOSS

Immediate skin-to-skin contact for
very preterm infants in HIC setting

Sweden and Norway



Photo: Stina Klemming

Courtesy Stina Klemming, klemming.stina@gmail.com



World Health
Organization

KMC provides for humanized and cost-effective, yet high-quality maternal and newborn care regardless of technological or resource gaps. It empowers mothers to lead the physical and emotional care of their infants, thus improving the health and well-being of infants and mothers alike (1).

Kangaroo mother care: Implementation strategy for scale-up adaptable to different country contexts. WHO 2023



Courtesy Stina Klemming, klemming.stina@gmail.com

The new recommendations require a restructuring of maternal & neonatal units

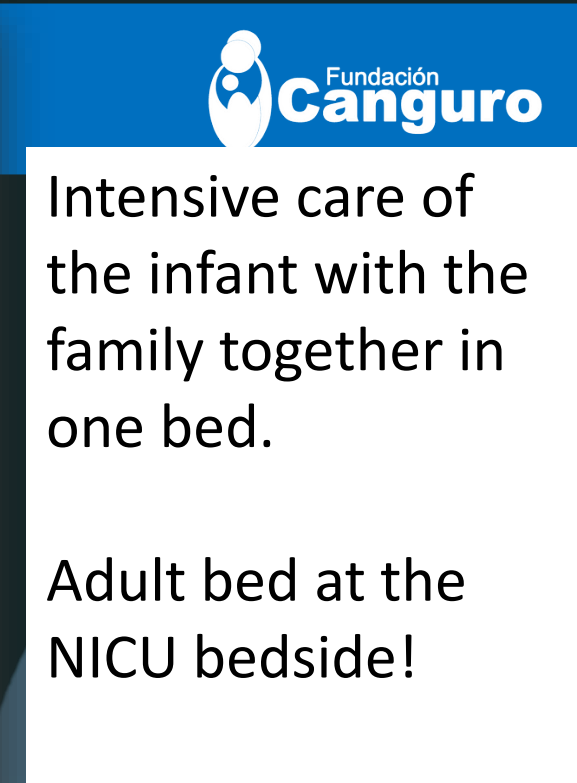


- Change layout of SNCU/NICU infrastructure to enable mother to be together with her preterm or LBW infant even when sick.
- Postnatal and KMC wards: Accommodate fathers and other family members who can also provide KMC and ensure infants receive KMC as close to 24 h per day as possible.

"Ensuring mothers and babies everywhere can stay together after birth will in many cases require a radical rethink of how newborn care is provided - these new publications aim to support this process."

... require a radical rethink...

Courtesy Stina Klemming, klemming.stina@gmail.com



Swedish guideline on Immediate and Uninterrupted Skin-to-Skin Contact and Mother-Newborn Couplet Care

The Swedish guideline

*Swedish guideline on
Immediate and Uninterrupted
Skin-to-Skin Contact and
Mother-Newborn Couplet Care*

National Program Area for Newborn and Adolescent Health

The Swedish Association of Local Authorities and Regions

Courtesy Stina Klemming, klemming.stina@gmail.com

Swedish guideline on
Immediate and Uninterrupted
Skin-to-Skin Contact and
Mother-Newborn Couplet Care

When either the mother or the newborn is discharged,
care is no longer defined as couplet care

Children should be with, and in physical
closeness to a parent during all hospitalization!



Go mobile!

Immediate skin-to-skin contact at birth Requirements and equipment for safe flexible care



Baby on CPAP
in skin-to-skin contact



Photos: Stina Klemming

Prone tucked
FETAL position
Cover
Nasal CPAP

GA w28+2, 1052 grams
Good vital parameters

Place is different – Care is the same!

90 seconds old

100 seconds old

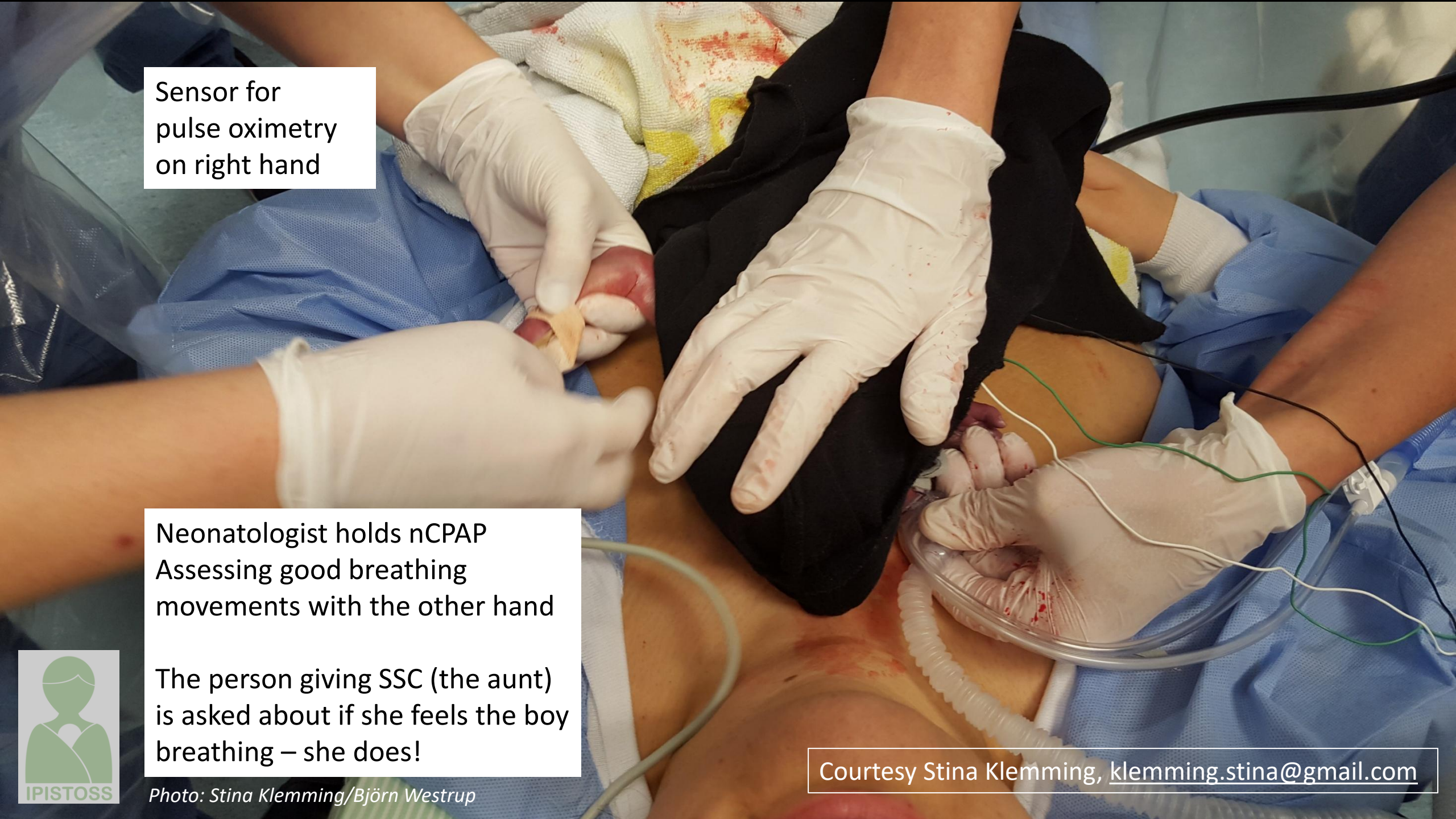
Electrodes in a
V-shape on the back

Merino wool-blanket

Courtesy Stina Klemming, klemming.stina@gmail.com

Photos: Stina Klemming/Björn Westrup





Sensor for
pulse oximetry
on right hand

Neonatologist holds nCPAP
Assessing good breathing
movements with the other hand

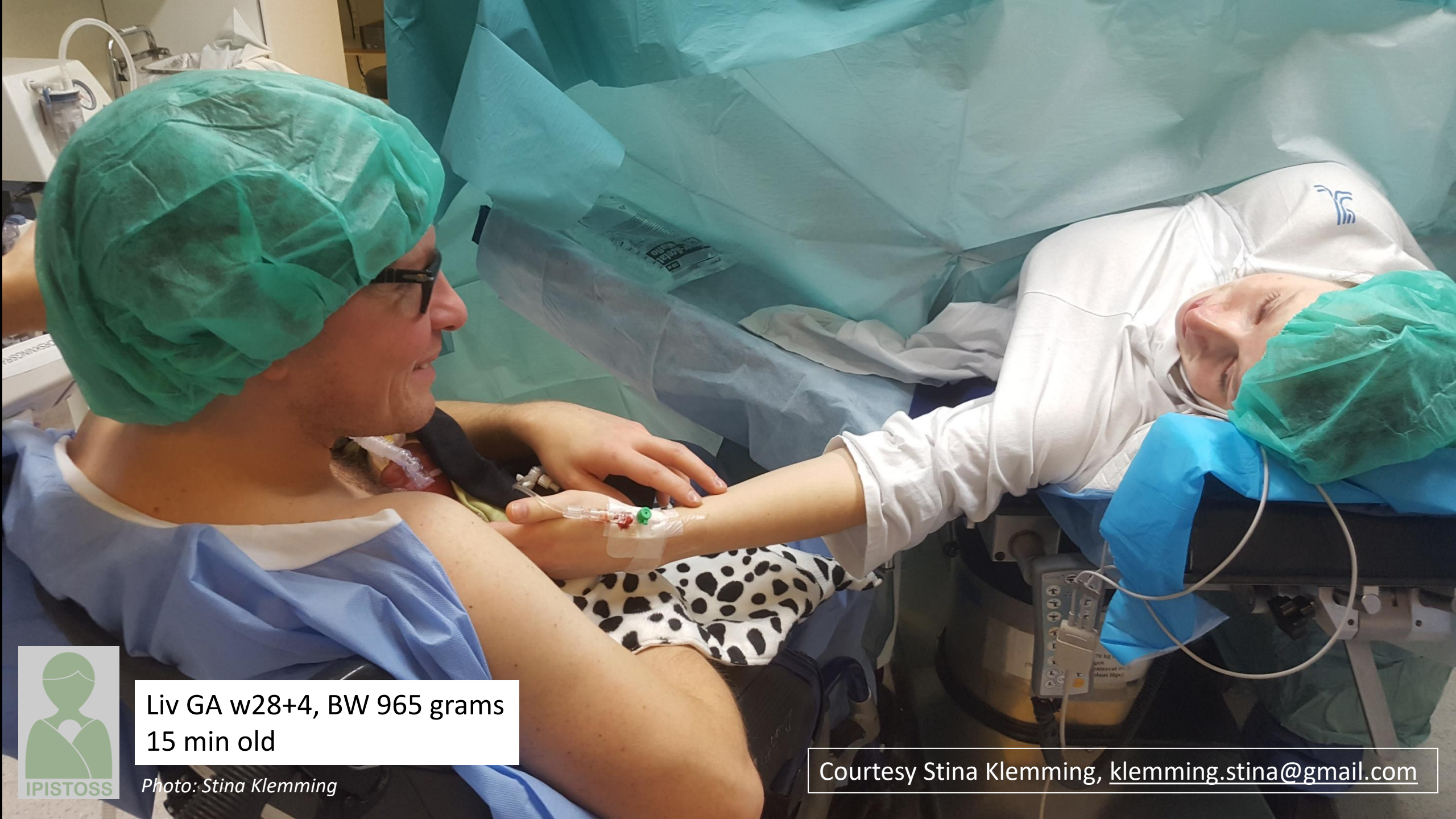
The person giving SSC (the aunt)
is asked about if she feels the boy
breathing – she does!

Photo: Stina Klemming/Björn Westrup

Courtesy Stina Klemming, klemming.stina@gmail.com



Cover well with wool blanket
Warm towels/blankets around (new warm)



Liv GA w28+4, BW 965 grams
15 min old

Photo: Stina Klemming

Courtesy Stina Klemming, klemming.stina@gmail.com



Radical rethink!

Zero separation Parents as the primary caregivers

Child's best interest!

We see a new parental behaviour with:

- ✓ Increased parental participation in care
- ✓ Earlier SSC and longer time of SSC – day and night



Photos: Stina Klemming

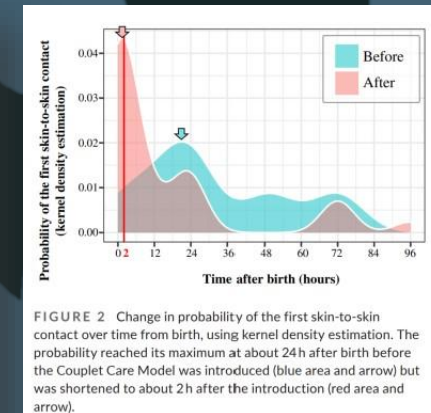




Photo: Stina Klemming



Photo: Stina Klemming

Benjamin GA w32+1
Immediate skin to skin contact with his mother
Zero Separation - Always Together!

Courtesy Stina Klemming, klemming.stina@gmail.com



Spain





Hosp 12 de Octubre, Madrid



Hosp 12 de Octubre, Madrid

Immediate KMC in delivery room, twins birth, 26 weeks gestational age, 70h post partum. Vietnam



Skin-to-skin contact with epidural anesthesia in operating rooms



Cortesy Dra. Kim Chi Luong

Skin-to-skin contact with CPAP—breastfeeding during and after a C-section



Cortesía Dra. Kim Chi Luong

SSC with CPAP

Giving expressing colostrum - 30 minutes old



Courtesy Dr Kim Chi Luong

Ssc with CPAP - Zero separation

26 weeks < 1000 g



Courtesy Dr Kim Chi Luong

In-hospital KMC at San Ignacio Teaching Hospital



KMC as routine practice for the premature baby care in the newborn unit of HUSI



KMC as routine practice for the premature baby care in the newborn unit of HUSI



KMC as routine practice for the premature baby care in the newborn unit of HUSI



Timeframe: parental Kangaroo Mother Care and uninterrupted bonding from birth within the intensive care unit



Courtesy of Professor Uwe Ewald

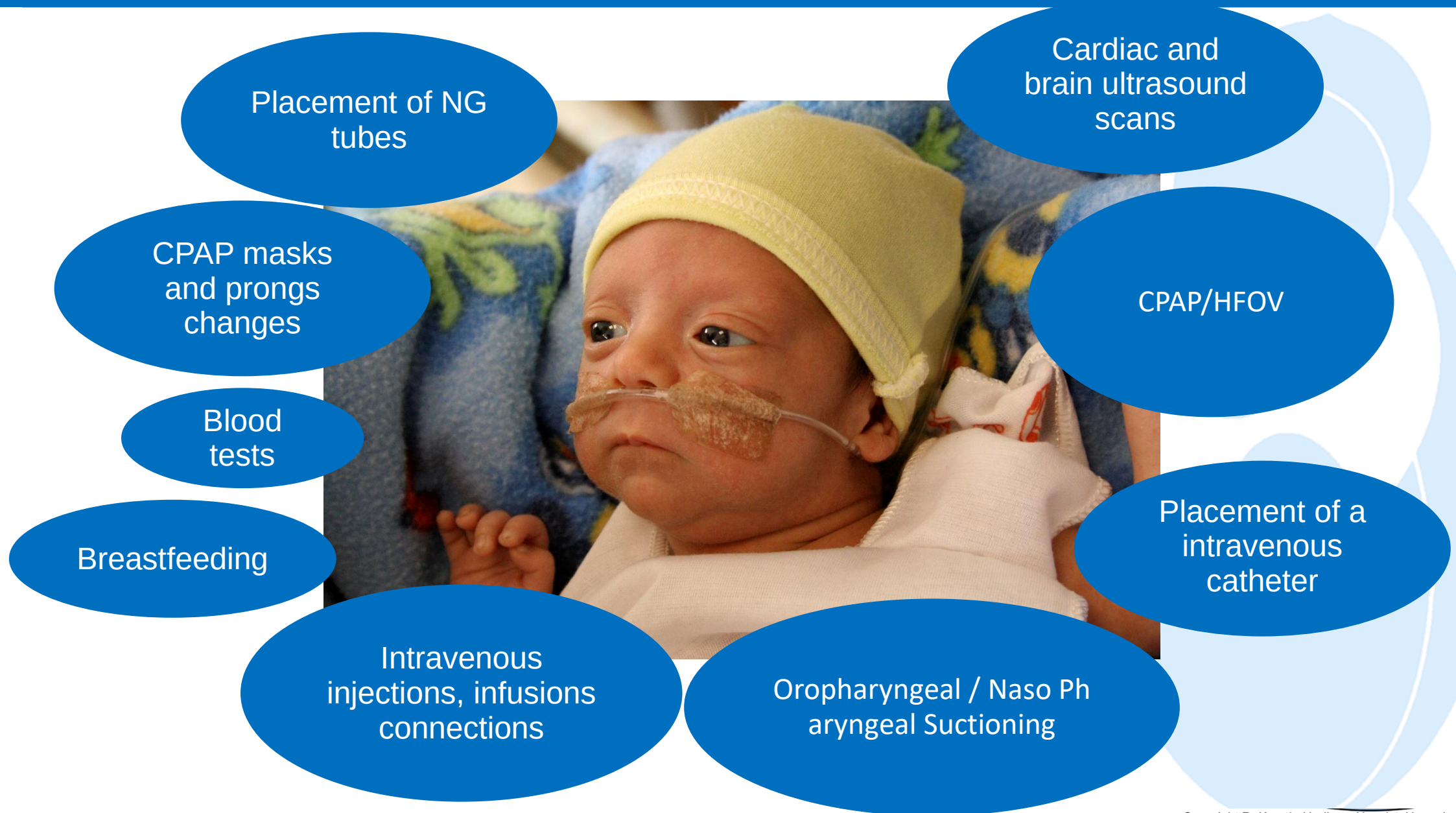


Parents' skin = a new space for care.



Photo courtesy
Pr Uwe Ewald

Procedures that can be performed in the kangaroo position





- The main goal: **Adequate Nutrition with Exclusive Breastfeeding** whenever possible from birth up the home discharge and during the follow-up

ACTA PÆDIATRICA

NURTURING THE CHILD

Review Article

Systematic review and meta-analysis suggest that the duration of Kangaroo mother care has a direct impact on neonatal growth

Nathalie Charpak✉, Adriana Montealegre-Pomar, Adriana Bohorquez

First published: 19 July 2020 | <https://doi.org/10.1111/apa.15489> | Citations: 6

[Read the full text >](#)

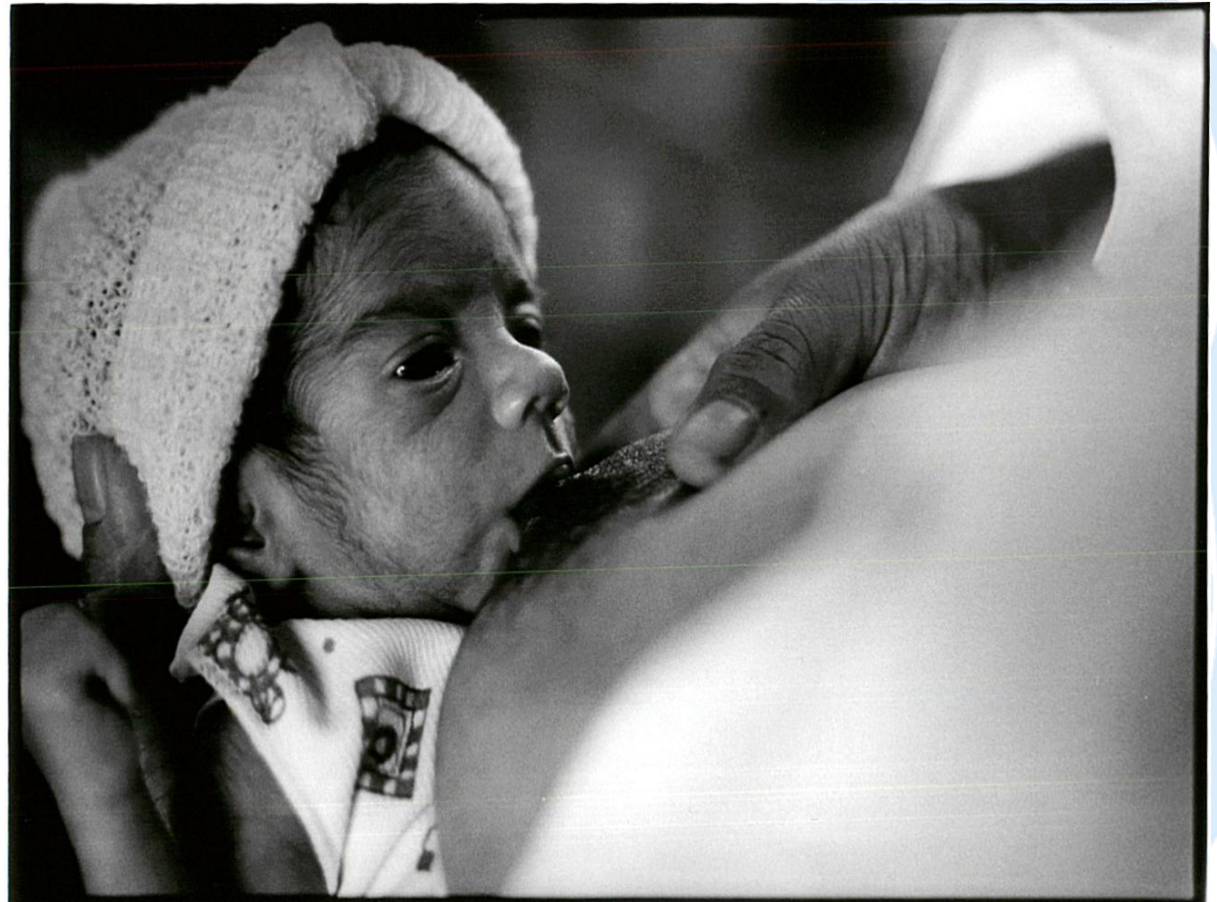
 PDF  TOOLS  SHARE

Abstract

Aim

A 2016 Cochrane review showed that Kangaroo mother care (KMC) had a moderate impact on preterm growth, with high heterogeneity among studies. This systematic review and meta-analysis considered new evidence on KMC, particularly the duration.

Method



Feeding twins



Exclusive breastfeeding whenever possible



...even for the most immature babies



NCU Upsala Sweden

TRANSFER IN- OUT/hospital



Ambulatory KMC: Early hospital discharge (home or Kangaroo ward) + Kangaroo Position + Kangaroo Nutrition + close monitoring

Child's eligibility criteria for home discharge(6)
Mother's eligibility criteria for discharge home(6)
Family's eligibility criteria for discharge home(6)



High risk follow-up in a KMC program

Ambulatory KMC (Up to 40 weeks of GA)

- **Initial daily monitoring**

Until weight gain of at least 15 g/kg/day

Then weekly until 40 weeks GA.

- **Kangaroo nutrition**

Based on BF, fortification and supplementation if necessary.

- **Medication**

Vitamins A, D, E, and K until 40 weeks gestational age.

- **Screenings**

Ophthalmological screening at 28 days of life (and/or 32-33 weeks)

Transfontanellar ultrasound for all babies if not performed during hospitalization.

Neurological assessment with the Amiel Tison evaluation at term

High risk follow-up (40 weeks up to 12 months of corrected age)

- Hearing and refraction assessment after the first trimester
- Frequency of follow-up from term (40 weeks PC) to corrected age
 - 5 neurological assessments (INFANIB test)
 - 2 to 3 psychomotor development assessments (GRIFFITH test with part of the BAILEY test).
- Nutritional follow-up
- Complete physical therapy if necessary
- Vaccination schedule
(BCG, DTaP, Polio, Haemophilus influenzae, Pneumococcus, Rotavirus, Hepatitis B, and MMR)

Kangaroo position at home

- Upright (strict) position, between maternal breasts, assisted with lycra band, under clothes, 24 hrs/7d.
- Sleeping in semi-seated position.

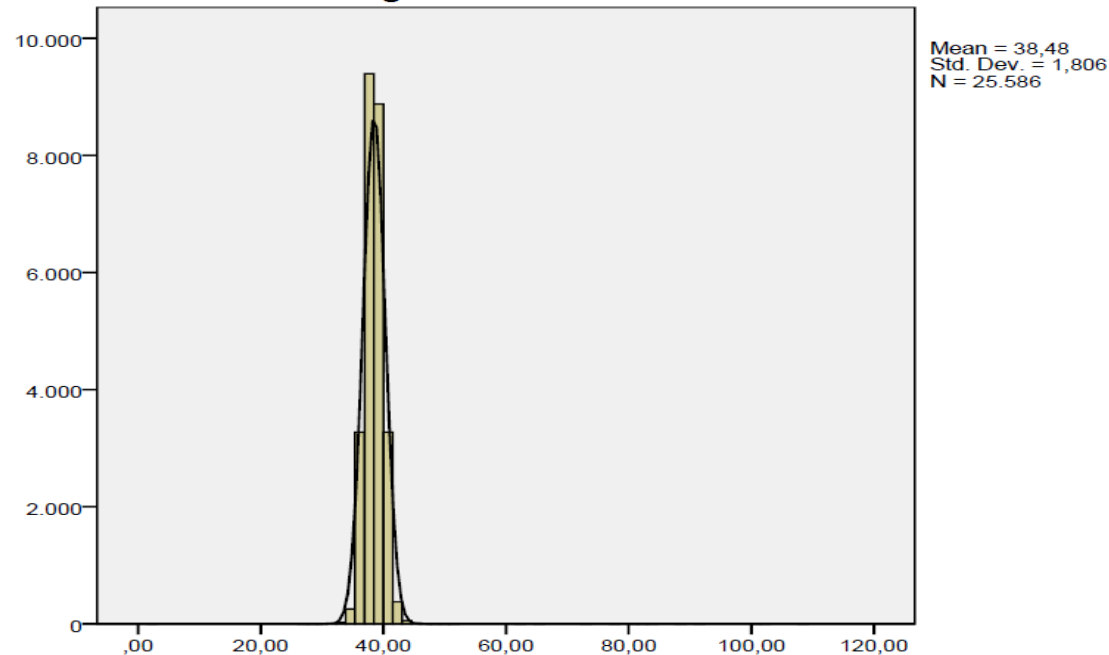


- Other people can (and should) replace the kangaroo mother.
- It is the baby who "asks" to come out of the Kangaroo Position.
- Do not forget Kangaroo clothing.

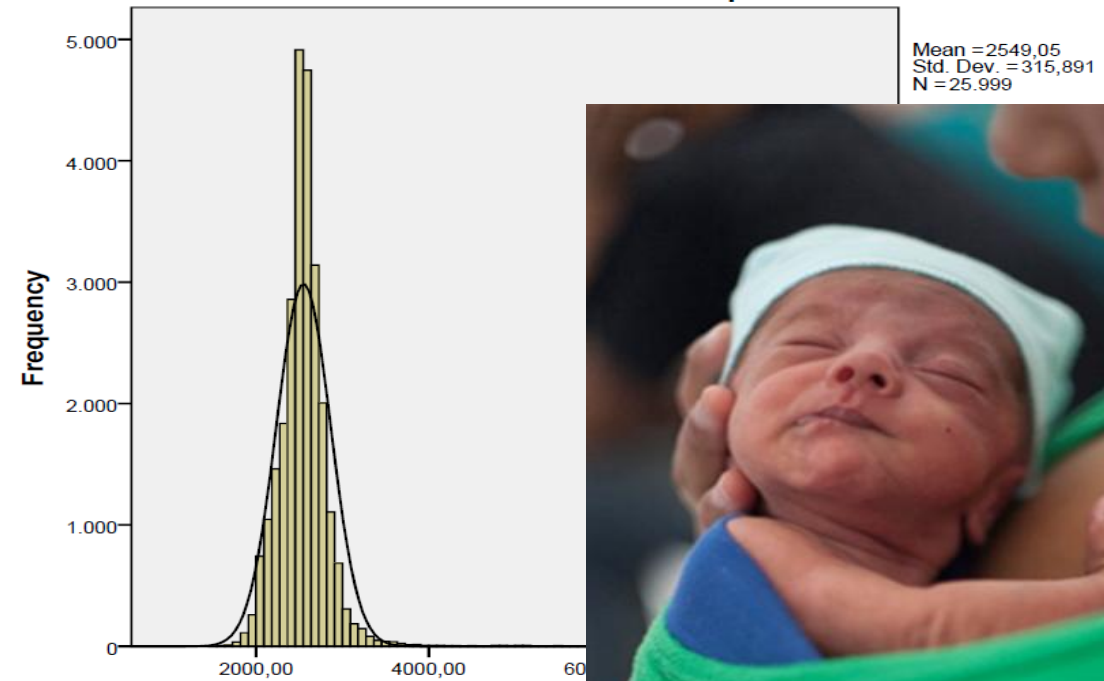
How long?

Gestational age and weight for leaving the kangaroo position

edad gestacional a la salida de la PC



Peso de salida de la pC



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NURTURING THE CHILD

BRIEF REPORT

Individual factors determine how long infants born preterm or with a low birth weight need to be kept in the Kangaroo position

Adriana Montealegre-Pomar ✉, Nathalie Charpak

First published: 28 October 2021 | <https://doi.org/10.1111/apa.16168>

KMC follow-up up to 40 weeks gestational age



The life of a kangaroo mother and her
baby at home

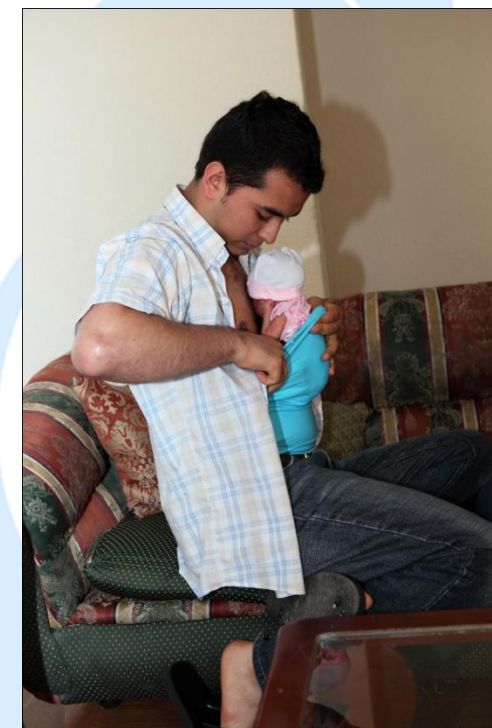
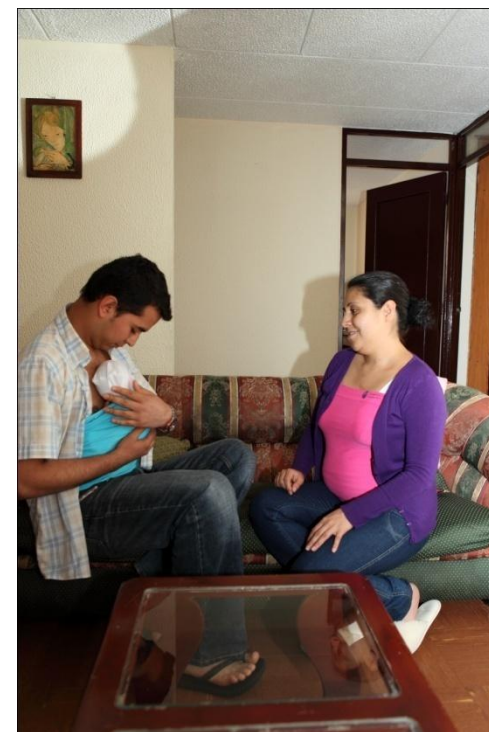


Parent education during KMC follow-up provided by a multidisciplinary team





A shared work for
the mother and the
father



Conclusion: KMC is indeed a complex intervention



There is no need to be afraid to place a premature or low birth weight baby in the Kangaroo Position in a neonatal unit.... but to be afraid of a mother who does not want to hold her baby in Kangaroo Position.

Where does KMC fits in standard neonatal care in 2026 ?

What is KMC for the premature baby?



Immaturity

Fragility

Unsuitable environment

KMC protects their progressive maturation: cerebral, pulmonary, digestive and physiological to obtain the best potential for neuro-psychomotor, sensory, nutritional, affective and cognitive development.

What is KMC for Premature Parents?



Trauma of early delivery

Separation

Loss of control

Death anxiety

Disability anxiety

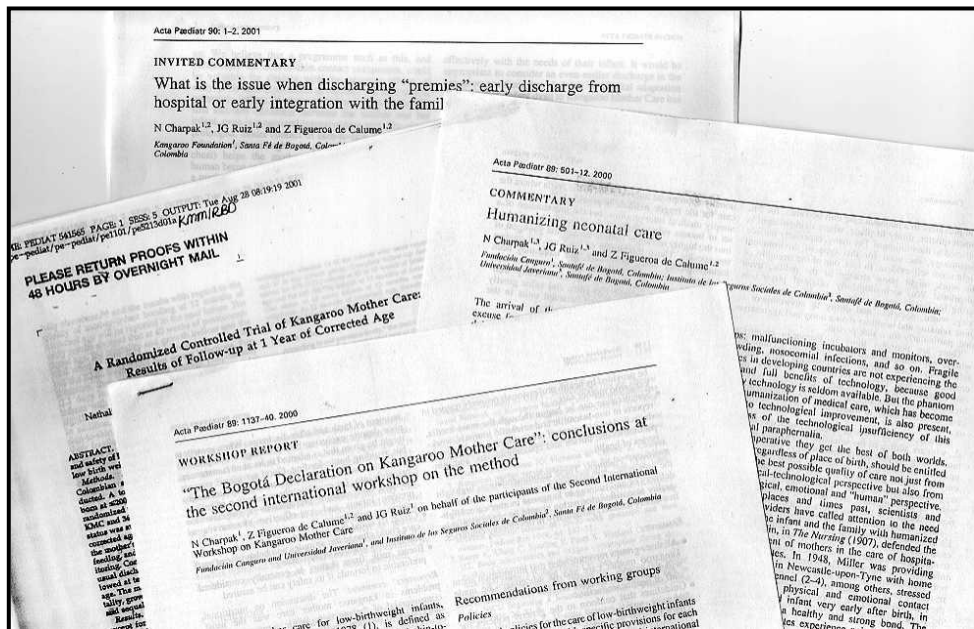
KMC empowers parents to feel like the best caregivers for their fragile baby.

Training in Kangaroo Position and Kangaroo Nutrition allows parents to know their baby, when he sleeps, when he is upset, what he needs.

2. Scientific, clinical and public health evolution of KMC from the original method to a globally evidence based recommended standard of care in Colombia and worldwide.

Colombia and the Kangaroo Foundation have been a key player in the evolution of KMC from an innovative idea (1989) to an evidence-based method of neonatal care (2026).

Rigorous scientific research was the path chosen in 1989 by the Kangaroo Foundation research team to demonstrate, as a first step, the safety and efficacy of KMC.



FIRST STEP



In 1989, **Dr. Nathalie Charpak, Dr. Juan Gabriel Ruiz**, professionals who later created the Kangaroo Foundation (1994), initiated a cohort study comparing the kangaroo group managed at IMI with a control group managed at the Social Security Institute of Colombia (ISS) (San Pedro Claver Clinic). These first results were published in 1994 in *Pediatrics*.

“In 1989 the Kangaroo Adventure began, with the same research line that has been going on for **more than 25 years** and with **more than 100 publications** on KMC.”



The Kangaroo Foundation was created in 1994 and the research group launched an experimental study on KMC at the ISS, creating a KMC program with a well-defined protocol, precise cut-off dates (follow-up up to 40 weeks of gestational age and then cut-offs at 3, 6, 9 and 12 months of corrected age), introducing a high-risk follow-up to detect any deviation in neuropsychomotor or sensory development and thus intervene in time to reduce the sequelae resulting from prematurity and/or low birth weight. **Dr. Zita Figueroa, neonatologist joins the research group**





Professor Rejean Tessier, Director of the School of Psychology at Laval University in Quebec City, joined the KMC evaluation project in 1996 and up to date remains one of the researcher on the impact of KMC on the mother-father relationship with the premature child, on the family environment, and on the long-term effects of KMC on the neuromotor and cognitive development of the premature child.

Medical and psychological outcomes at one year of corrected age of the first RCT on KMC

Relative risk of dying
50% lower

Reduced nosocomial infection in KMC

Adequate growth

Mothers felt more competent and are more sensitive to their Infants need, especially if they were in the NICU. Children are more responsive to their mother.

There were protective effects on mortality and infectious morbidity especially when the father's level of education is low. Children in the kangaroo group have higher Growth and Development. This difference is more significant when the children passed through the NICU and had a transient neurological state at 6 months (Infanib).

Maternal breastfeeding rate was higher in the kangaroo group.

Children spent less time in the hospital

Kangaroo families provided a more stimulating environment for the child.

Pediatrics 1997;100:682-8, Pediatrics 1998;102(2):e17, .Pediatrics 2001; 108(5); 1072-79, Infant behavior and development 26(2003) 384-397

“Casita Canguro” and the “Kangaroo Mother Care program”(PMCI)

The kangaroo house at the Clínica del niño (ISS) was the center for research and training between **1993 and 2001**. It was the place where the first RCT on the safety and effectiveness of KMC was conducted, where the first evaluations on the relationship between mother and premature infant in KMC have been carried out and where the training in KMC of national and international professional teams began.

Subsequently, **in 2001** the Kangaroo Foundation created the first research model center for training and implementation of KMC at the **Hospital Universitario San Ignacio**, recognized as the first Programa Madre Canguro Integral (PMCI). With the subsequent formation of the PMCI of the Hospital Universitario San José and the PMCI of Medellín (2008). **Every year, 4,000 new children are admitted to these three KMC programs and added to the KMC database, which now includes more than 70,000 premature or LBW babies.**

The “Fundacion Canguro”/Kangaroo Foundation



FUNDACIÓN CANGURO

Categoría: [Centros / Institutos de Investigación](#)

Sector: Salud

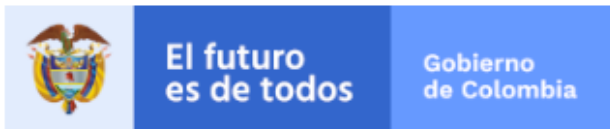
[Sitio web](#)

www.fundacioncanguro.co



Es una organización sin ánimo de lucro, liderada por profesionales de la salud, con la misión de humanizar la neonatología a través de la aplicación del Método Madre Canguro (MMC) en el cuidado de los niños recién nacidos, particularmente de los más frágiles: prematuros y con bajo peso al nacer (BPN). Desarrolla investigación para el mejoramiento continuo, la difusión a través del entrenamiento de profesionales de la salud, el monitoreo de calidad de los resultados para garantizar la seguridad y eficacia de los cuidados canguro para el niño y su familia y la traducción y transferencia de las evidencias en políticas de salud acerca del Método Madre Canguro y del bienestar de la infancia.

Su Centro de investigación se reconoce por Colciencias como actor del SNCTel mediante resolución 487 DE 2018 y se encuentra vigente hasta mayo de 2021.



■ Presidencia
■ MinHacienda
■ MinAmbiente

■ Vicepresidencia
■ MinMinas
■ MinTransporte

■ MinJusticia
■ MinCIT
■ MinVivienda

■ MinDefensa
■ MinTIC
■ MinEducación

■ MinInterior
■ MinCultura
■ MinTrabajo

■ Cancillería
■ MinAgricultura
■ MinSalud

We are a recognized group by the Ministry of Science and Technology in Colombia

Research Group: Kangaroo Foundation

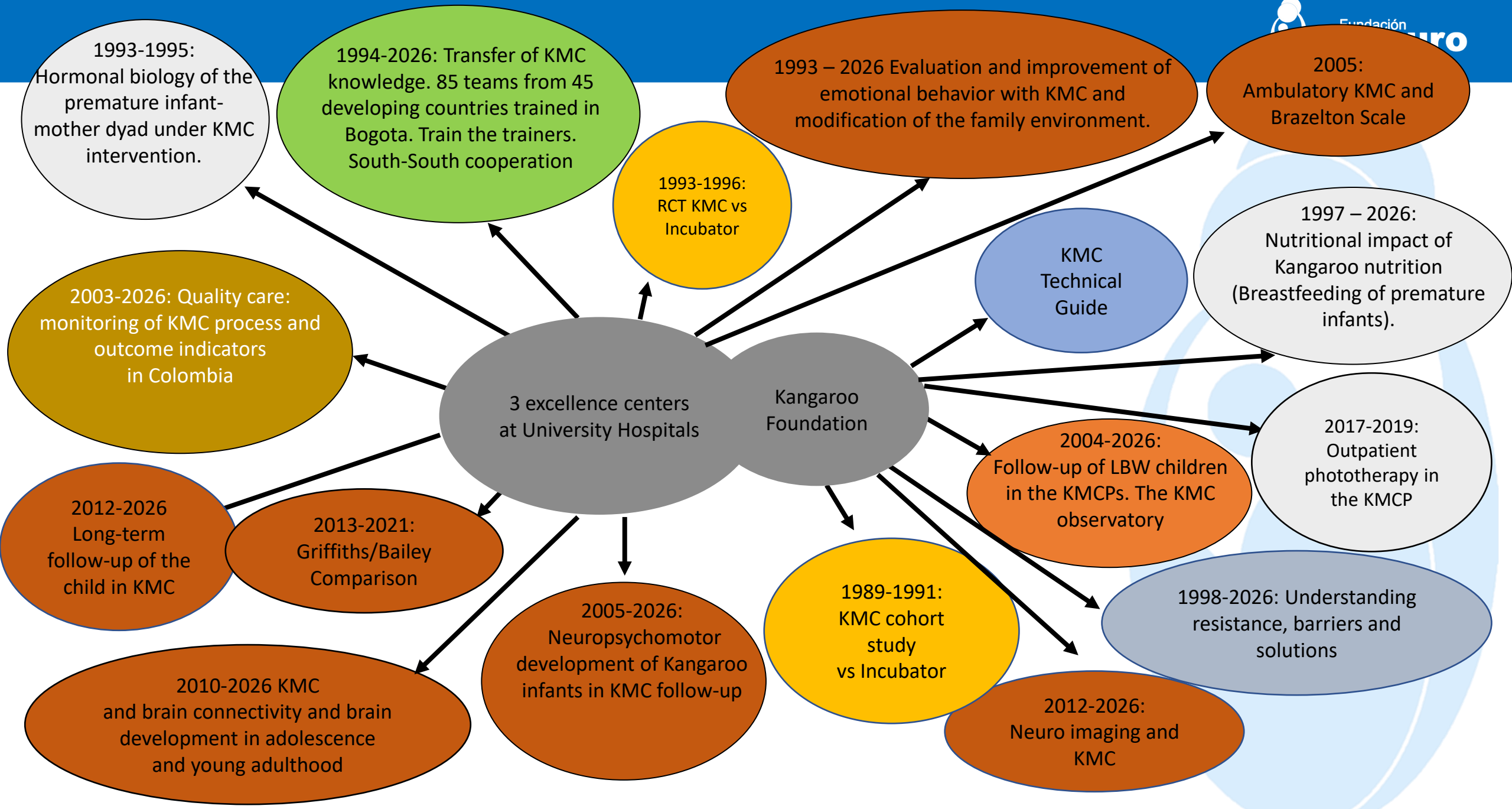
Classification: A1.

Our history



In these 26 years, the Kangaroo Foundation has maintained the publication of scientific evidence from researchs conducted in the 3 centers of excellence (“Programa Madre Canguro Integral”), through the strengthening of strategic alliances with academia, goverment and non-government organizations, nationals and internationals.

- Psycho-affective and emotional developmental outcomes of mother-child-father bonding and family environment of preterm and low birth weight infants.
- Establishment of KMC quality monitoring
- Refinement of the intervention, evaluation of psychomotor development in preterm and low birth weight infants followed in outpatient KMC and of the different tests used for their evaluation.
- Evaluation of the intervention by improving neurological and neurodevelopmental aspects and brain impact.
- Evaluation of the intervention by improving the nutritional aspects of the mother-child kangaroo dyad.
- Evaluation of the intervention by improving the pulmonary aspects.
- Generalization of the intervention, dissemination, transfer of acquired knowledge and resistances to the implementation of the KMC and proposed solutions to remove barriers
- Materials and guidelines
- Mortality and morbidity and follow-up of preterm or low birth weight infants exposed to KMC, short, medium and long term impacts.
- Transport of the infant in the kangaroo position

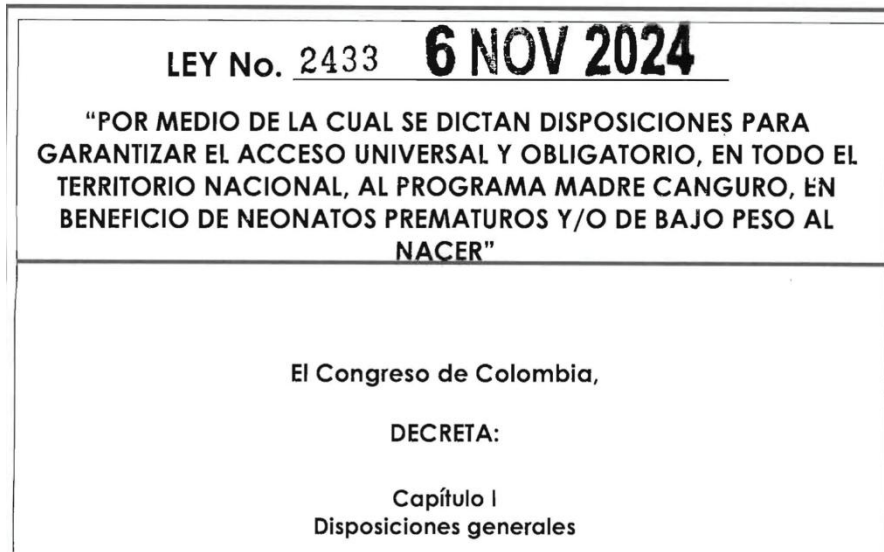


Is there a support from the authorities for specific monitoring in the KMC programs?



The Colombian Ministry of Health published rules for Kangaroo Mother Care Programs in 2017 (Update in progress for 2026) and a resolution in 2018 establishing the maternal-perinatal pathway for these vulnerable infants

Is there a political support for the KMC in Colombia?



In 2024, the “**Ley Canguro**” (Kangaroo Law) was adopted in Colombia, guaranteeing universal and mandatory access to a Kangaroo Mother care Program for all premature and/or low-birth-weight newborns, protecting their fundamental right to health.

Who is in the monitoring team?

A multidisciplinary team



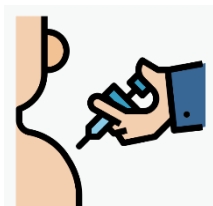
Pediatrician or neonatologist: pediatric and nutritional follow-up and all neurological screenings.



Nurse: Specialist in breastfeeding for premature infants.



Clinical psychologist: applies psychomotor development tests and supports mothers in crisis due to having a premature or low birth weight baby.



Nursing assistant: for vaccination and dynamic oximetry.



Who makes up the monitoring team?

Other members of the multidisciplinary team working in the KMC program:

Social worker

For specific social problems of families.

Retinologist

Available once a week. Infant's pupils are dilated one hour prior to screening and he can see 30 infants in 4 hours.

Optometry

For refractive problems. Screening twice a week.

Speech-language pathologist

For otoacoustic emissions and systematized evoked potentials, twice a week.

Physiotherapist

For parents stimulation workshops

Other services available (as needed)

Neuropediatrician, pediatric nephrologist, pediatric pulmonologist, etc.



What screening tools exist?



Screening for retinopathy of prematurity (ROP): At 28 days or at 33-34 weeks.
Monitoring until complete maturation of the retina.



Neurological screening: At 40 weeks with Amiel Tison evaluation at term. Referral for physical therapy if necessary.
P. Ellison INFANIB at 3, 6, 9 and 12 months corrected age.
Home exercises or referral to physical therapy if INFANIB is not normal.
Griffiths 2 test plus Bayley II behavioral scale at 6 and 12 months of corrected age, with home exercise teaching or referral to physical therapy.

What other screening tools?

Audiometric screening: Between 40 weeks and 1 month corrected, with otoacoustic emissions and systematized evoked potentials.



Brain ultrasound: On admission to the KMC program if not performed during hospitalization.



What other screening tools?



- **Visual refraction:** Detection of visual refraction problems from 3 months of corrected age.

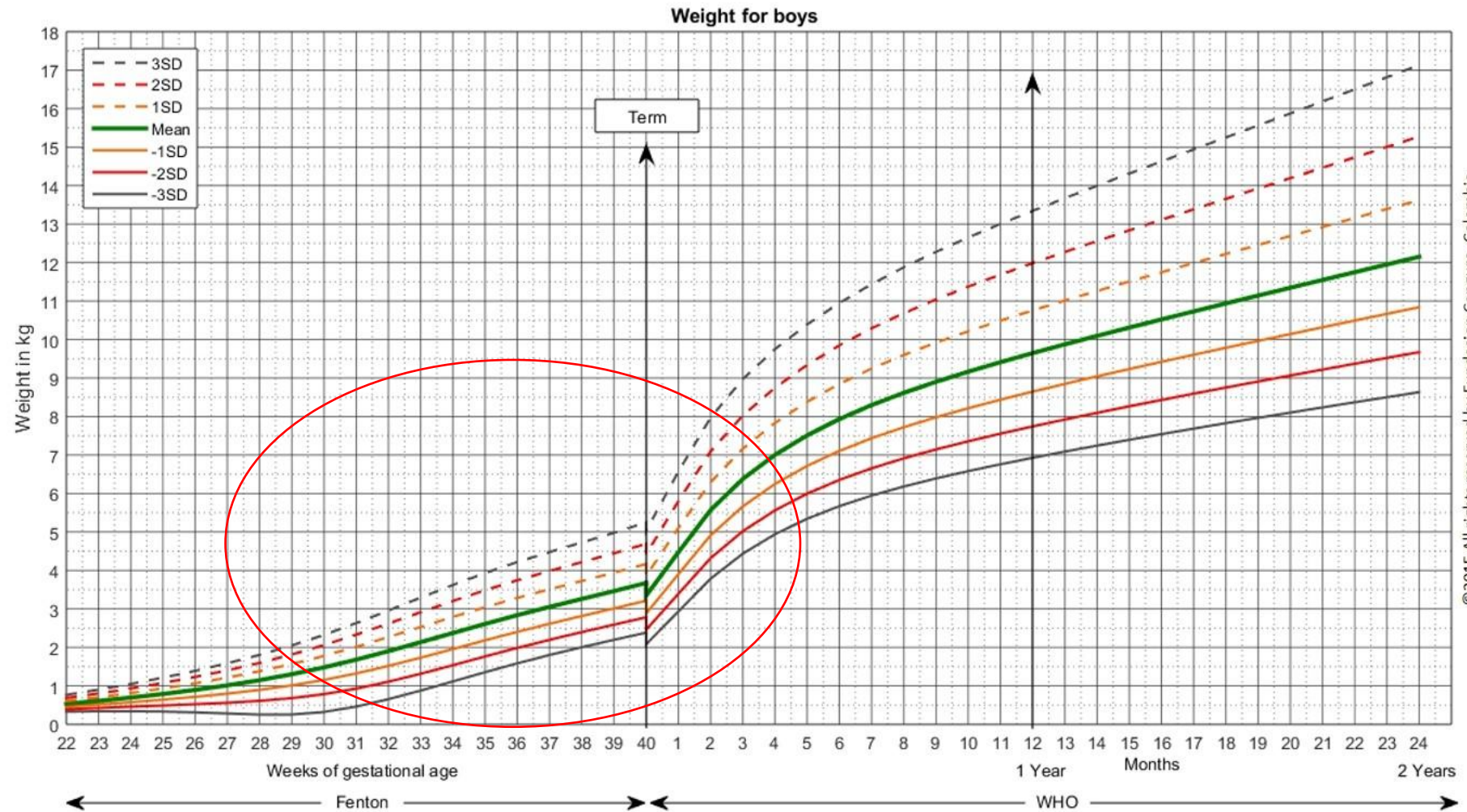


Somatic growth monitoring: Fenton curve before 40 weeks.
WHO curve between 40 weeks and 12 months of corrected age.

Additional tests such as an MRI or referrals to specialists may be requested at any time if necessary.



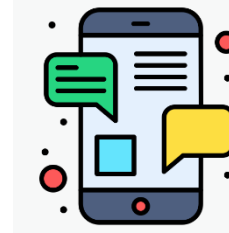
Somatic growth monitoring



Specific support to families



- Calls if they do not attend a consultation.



- Answered hotline with pediatrician before 40 weeks.

Controls in the KMC program

Initial daily controls until the baby gains 15g/kg/day.

Then weekly controls until 40 weeks. Parents can return without appointments if alarm signs appear or if they are frightened.

From 40 weeks to 12 months of corrected age, appointment monthly or every 6 weeks according to the PMC.



Specific accompaniment of families



Psychological and nursing workshops are organized with the families. These workshops include regular educational activities for new kangaroo parents.

They address the restructuring of family dynamics, guidance on child development, guidelines for education, strategies for coping with crises and fostering bonding, among other topics.

Are the caregivers (parents and children) fully covered financially by health insurances?

Public or private insurance covers the follow-up included in the "kangaroo package".

Other exams are requested with a doctor's order to the insurer.



Kangaroo E-learning platform in French, English, and Spanish

← → ↻ fundacioncanguro.co ☆ □ Error

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Portal de Formación en Método Madre Canguro



Kangaroo Mother Care Method

An introduction to the Kangaroo Mother Care Method.

Ver video »



TEDx Nathalie Charpak

Nathalie Charpak nos muestra como el calor de una madre o un padre es más eficiente que una incubadora cuando tenemos un bebé prematuro.

Ver video »

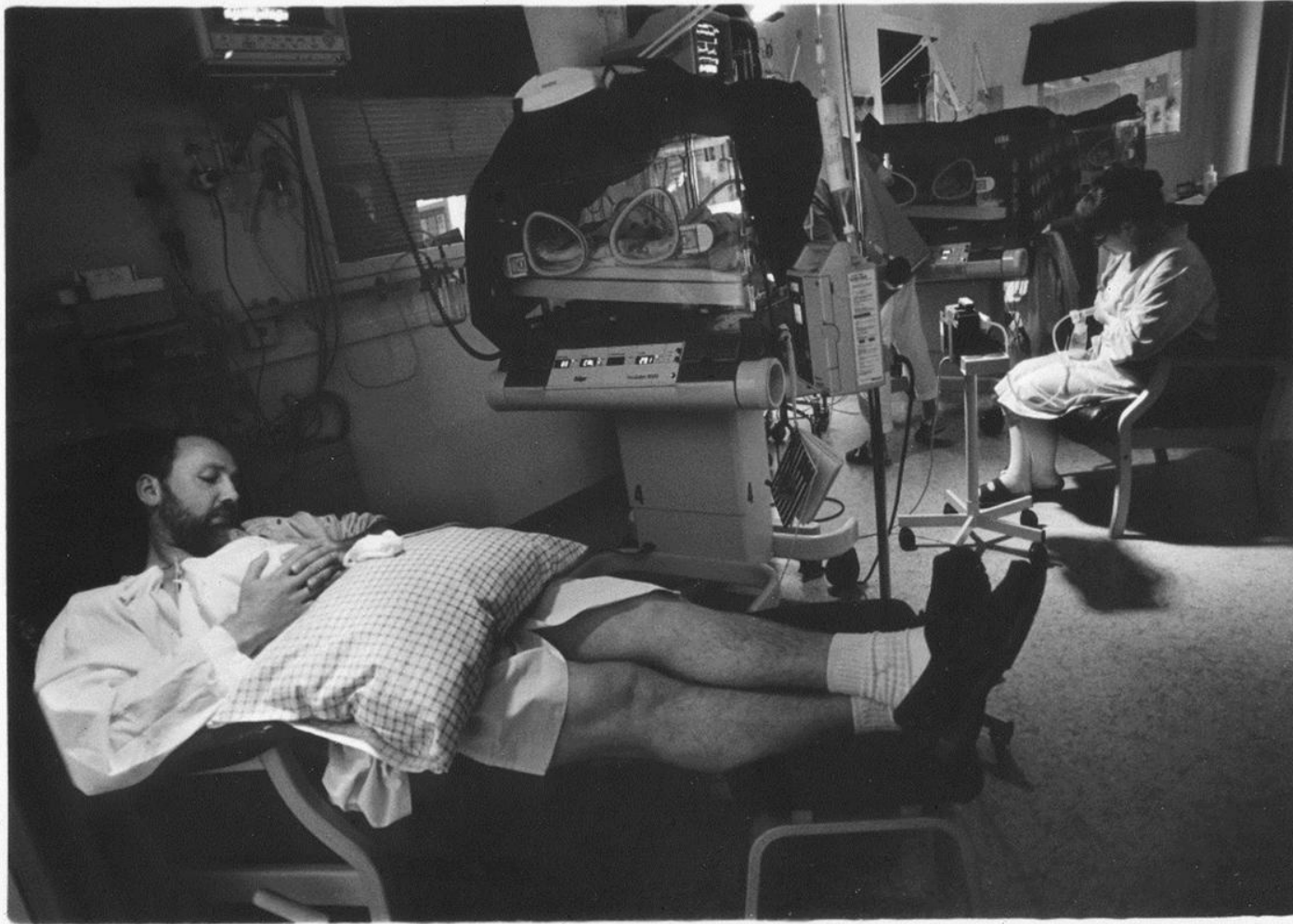


Mamá Canguro Andrea Echeverri

Canción Mamá Canguro por Andrea Echeverri

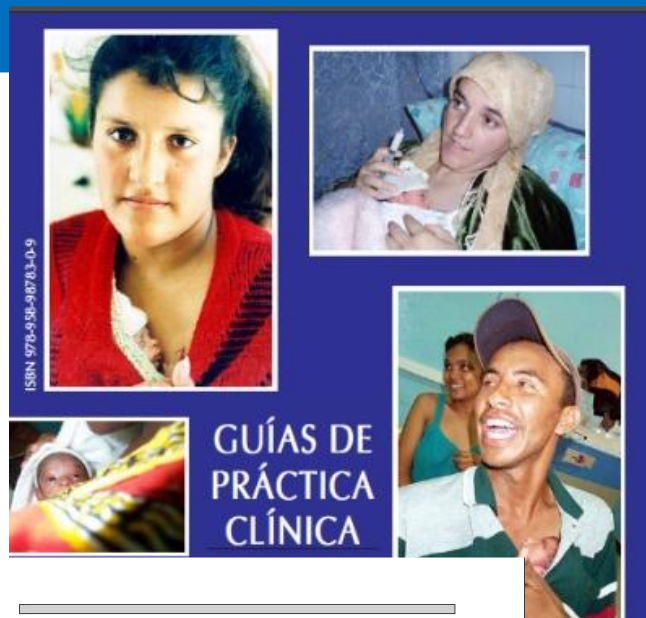
Ver video »

KMC is no longer considered a 'poor man's' alternative. It is a physiologically, humanely, and emotionally appropriate intervention for all premature infants and enhances neonatal care at every stage.



Guidelines & Protocols





Optima Utilización del Método Madre Canguro en el Neonato Prematuro y/o de Bajo Peso al Nacer

Actualización 2021
Bogotá D.C., Colombia



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Guía práctica



Departamento de Salud Reproductiva e Investigaciones Conexas
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Ginebra



Comparing long-term educational and health interventions

Darwin Cortés^{a,*}, Darío Rejean Tessier^d, Juan Julieth Pico^a

^a School of Economics, Universidad del Rosario
^b School of Government, Universidad de los Andes
^c Kangaroo Foundation, Colombia

Clinical Practice Guidelines Evidence-based Guidelines for the optimal use of Kangaroo Mother Care for the preterm or LBW infants

The Effect of the Kangaroo Mother Care Program (KMC) on Wages: A structural Model

In this paper we analyze the relationship between skills and some outcomes later in life for a population of premature children. Pretreatment skills and characteristics are good predictors of childhood and adulthood skills and outcomes. Income per capita and parents education at birth are positively correlated with home environment at 6 and 12 months of corrected age. Moreover, parents education and the proportion of workers at home are correlated with the number of preschool years attended by children. Interestingly, health indicators taken during the first year of life are critical factors for decision to enroll into a university, to obtain better results in math scores and earn larger wages.



ARTICLE | JANUARY 01 2017

Twenty-year Follow-up of Kangaroo Mother Care Versus Traditional Care

Nathalie Charpak, MD^a, Rejean Tessier, PhD^b, Juan G. Ruiz, MD^c, Jose Tiberio Hernandez, PhD^d, Felipe Uriza, MD^d, Julieta Villegas, MD^d, Line Nadeau, PhD^d, Catherine Mercier, PhD^d, Françoise Maheu, PhD^d, Jorge Marin, MD^d, Darwin Cortes, PhD^d, Juan Miguel Gallego, PhD^d, Darío Maldonado, PhD^d

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Article history

Development Team

Methodological Team

Adriana Patricia Bohórquez
Methodological Expert
Physician specialist

PEDIATRIC PULMONOLOGY

ORIGINAL ARTICLE: NEONATAL LUNG DISEASE

Anemia, nutrition, and ambulatory oxygen weaning in a cohort of oxygen-dependent premature infants

Adriana del Pilar Montealegre-Pomar MD, MSc^a, Nathalie Charpak MD^b

First published: 01 February 2021 | <https://doi.org/10.1002/ppul.25288>

Nathalie Charpak contributed equally as the cofirst author.

Read the full text >

Abstract

Background

In Bogotá, Colombia, oxygen-dependent (OD) preterm infants are home discharged in Kangaroo Position, to a Kangaroo Mother Care Program (KMCP) with ambulatory oxygen, strict follow-up, and oxygen weaning protocols.

Objectives

(1) To describe growth, morbimortality, and oxygen monitoring up to 6 months in OD preterm infants. (2) To explore associations between oxygen weaning, perinatal history, Hb levels, transfusions, feeding patterns, and growth.

Methods

A prospective cohort study. Descriptive and multivariate analysis.

October 2019 | Revised: 26 December 2019 | Accepted: 6 January 2020

15161

WILEY

review and meta-analysis suggest that Kangaroo Position protects against apnoea of prematurity

Pomar^{1,2} | Adriana Bohorquez³ | Nathalie Charpak^{1,2}

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²Kangaroo Foundation, Bogotá, Colombia

³Department of Clinical Epidemiology, Faculty of Medicine, Pontificia Universidad

Abstract

Aim: The aim of this study was to determine whether the Kangaroo position decreased apnoea events in preterm newborns compared with conventional incubator.

Received: 29 April 2020 | DOI: 10.1111/apa.15489 | Revised: 28 June 2020

REVIEW ARTICLE

Systematic review and meta-analysis suggest that the duration of Kangaroo mother care has a direct impact on neonatal growth

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Funding information: Kangaroo Foundation of Bogotá

Abstract

Aim: A 2016 Cochrane review showed that Kangaroo mother care (KMC) had a moderate impact on preterm growth, with high heterogeneity among studies. This systematic review and meta-analysis considered new evidence on KMC, particularly the duration.

Method: Databases were searched for papers published in English, French, Spanish and Portuguese up to 2017. Randomised controlled trials (RCT) of preterm or low birth weight infants were included if they compared growth between KMC and conventional care. Anthropometric measures were related to duration.

Results: We identified 1368 papers, and 13 RCTs covering 743 KMC infants and 718 controls met the selection criteria. Infants held in KMC for at least 6 h/d gained more weight than the controls, with a mean difference of 8.99 g/d (95% confidence interval 8.14–9.84, $I^2 = 0\%$). This difference persisted between 2 and 6 h/d and disappeared with 2 hours or less. When we used g/kg/d, the weight gain was higher when the duration was at least 8 h/d. Only babies who received 6 h/d gained more length and head circumference.

Conclusions: The effect of the KMC on growth was directly related to the duration.

Normas para mejorar la calidad de la atención a los recién nacidos enfermos o de pequeño tamaño en los establecimientos de salud



2023

IEEE Access

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Digital Object Identifier 10.1109/ACCESS.2023.3239972

RESEARCH ARTICLE

VALS: Supporting Visual Data Analysis Longitudinal Clinical Studies

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¹Department of Systems and Computing Engineering, Universidad de los Andes, Bogotá, Capital District 111711, Colombia
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This work involved human subjects or animals in its research. Approval of all ethical and experimental procedures granted by the Ethical Committee from the School of Medicine of Universidad Javeriana (Bogotá, Colombia) Fundación Santafé de Bogotá (Bogotá, Colombia).

ABSTRACT Visual data analysis helps to understand different types of phenom to explore for relationships, patterns, outliers, unexpected changes, and more. Existing find useful and actionable information in the data so that they can test their new ones. This need becomes more evident in longitudinal studies, where there are variables and the process being analyzed can be complex as well. We present VALS (Visual Longitudinal Studies), a framework for visually exploring longitudinal clinical data model, a task categorization model, and an approach to guidance through feature and interactive visualizations, all of which help analysts perform their analysis task in collaboration with healthcare experts with experience in longitudinal studies. VALS tool prototype for a case study using real-world datasets. The evidence collected in usefulness of a VALS-based visual analytics tool.

2024

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Perinatal risk factors in ex-preterm and/or low birthweight Colombian young adults: a retrospective cohort study on auditory and visual impairments

Nathalie Charpak^{a,b}, Adriana Montealegre-Pomar^{a,b,c}, Lyda Teresa Rosero^a, Catalina Lince-Rivera^{a,c}, Darwin Cortés^d

Affiliations & Notes Article Info

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2025

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COMMENT · Volume 407, Issue 10523, P7-9, January 03, 2026 Download Full Issue

A clinical practice guide to transform care and save newborn lives with kangaroo mother care

Shuchita Gupta^a, Gary L Darmstadt^{b,c}, Betty Kirkwood^c, Per Ashorn^a, Ebinoluwa Adejuyigbe^d, Nils Bergman^e, Nathalie Charpak^f, Harish Chellani^g, Nicholas Embleton^h, Elizabeth Franklinⁱ, Silke Mader^j, Samilla Mazumder^k Show less

Affiliations & Notes Article Info

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Preterm birth complications are the leading cause of deaths among newborns and children younger than 5 years worldwide, contributing to an estimated 36% of neonatal mortality and 18% of under-5 deaths globally.¹ Kangaroo mother care (KMC)—prolonged skin-to-skin contact (8–24 h daily) with support for exclusive breastfeeding or breastmilk feeding—is one of the most effective interventions to reduce mortality, infection, and hypothermia in newborns, while also promoting growth and neurodevelopment.² However, despite compelling evidence and decades of global endorsement, KMC coverage remains fragmented, inconsistent, and grossly inadequate.³

weight (LBW) infants but raised concerns about inatal factors linked to visual and auditory impairment.



Aboubaker, S., Aluvaala, J., Ariff, S., Asfaw, A. G., KC, A., Ayede, A., ... & Yunis, K. (2025). Measuring ENAP interventions for small and/or sick newborns in routine health information systems: indicators and considerations from a WHO expert consultation. *Journal of Global Health*, 15.

Original research

Follow-up of Kangaroo Mother Care programmes in the last 28 years: results from a cohort of 57 154 low-birth-weight infants in Colombia

Nathalie Charpak¹, Adriana Montealegre-Pomar^{1, 2, 3}

Correspondence to Dr Nathalie Charpak; ncharpak@gmail.com

PDF PDF + Supplementary Material

Research Article

Birthweight Classification in Colombian Newborns: Agreement Between International and Local Growth Charts

Adriana Montealegre-Pomar¹ Email Cindy Margarita Atencia Herrera² Claudia Patricia Devia Neira² Catalina Lince-Rivera² Cristina Mujica Benavides² Kelly José Muñoz Ramírez² Miguel Andrés Otálora-Baquero¹ Yaris Anzully Vargas Vaca¹ Nathalie Charpak² Martín Alonso Rondón Sepúlveda¹ Magda Cristina Cepeda Gil¹

Immediate Kangaroo Mother Care in a Cohort of Low-Birth-Weight Infants (Less Than 1800 g) in Vietnam

Luong Kim Chi, Chu Van Quyen, Montealegre-Pomar Adriana, Charpak Nathalie

Acta Paediatrica 115(5):p 1130-1132, May 2026. | doi:10.1111/apa.70444

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Acta Paediatrica

2026

BRIEF REPORT

Immediate Kangaroo Mother Care in a Cohort of Low-Birth-Weight Infants (Less Than 1800 g) in Vietnam

Luong Kim Chi¹, Chu Van Quyen¹, Montealegre-Pomar Adriana², Charpak Nathalie²

Correspondence: Luong Kim Chi (luongkimchi@gmail.com)

Received: 10 August 2025 | Revised: 23 December 2025 | Accepted: 29 December 2025

Kangaroo mother care had a protective effect on the volume of brain structures in young adults born preterm

Nathalie Charpak , Réjean Tessier, Juan Gabriel Ruiz, Felipe Uriza, José Tiberio Hernandez, Darwin Cortes, Adriana Montealegre-Pomar

First published: 24 January 2022 | <https://doi.org/10.1111/apa.16265> | Citations: 12

Funding information

Grand Challenge Canada.

SECTIONS

TECHNOLOGY REPORT article

Front. Neuroinform., 23 August 2016 | <https://doi.org/10.3389/fninf.2016.00016>

A Multi-faceted Visual Analytics Tool for Exploratory Analysis of Human Brain and Function Datasets

Diego A. Angulo^{1*}, Cyril Schneider², James H. Oliver³, Nathalie Charpak⁴ and Jose T. Hernandez¹

¹IMAGINE, Systems and Computing Engineering, Universidad de los Andes, Bogota, Colombia

²LCNS, CHUL, Quebec, QC, Canada

³VRAC, Iowa State University, Ames, IA, USA

⁴Kangaroo Foundation, Bogota, Colombia

Title:

KMC and brain development: A plea for starting KMC as early as possible and as long as possible

Authors: Nathalie Charpak, MD ^{a,b}, Catalina Lince-Rivera, MD ^{a,c}, J.T.Hernandez, Eng, MSc, PhD ^a

Institutional Affiliations: ^a Kangaroo Foundation, ^b Pontificia Universidad Javeriana, ^c Hospital Universitario San Ignacio, Bogotá, Colombia

Articles

The long-term effects of the Kangaroo Mother Care intervention on cognitive functioning: Results from a longitudinal study

Stéphanie Ropars, Réjean Tessier , Nathalie Charpak & Luis Felipe Uriza

Pages 82-91 | Published online: 29 Jan 2018

Download citation <https://doi.org/10.1080/87565641.2017.1422507>



Early Human Development

Volume 110, July 2017, Pages 44-49



Long-term attention deficits combined with subcortical and cortical structural central nervous system alterations in young adults born small for gestational age

Sabrina Suffren ^a, Diego Angulo ^{b, c, d}, Yang Ding ^a, Pablo Reyes ^{c, e}, Jorge Marin ^f, Jose T. Hernandez ^d, Nathalie Charpak ^c, Gregory A. Lodygensky ^{a, g, h}

KMC diffusion: Observe, practice, teach

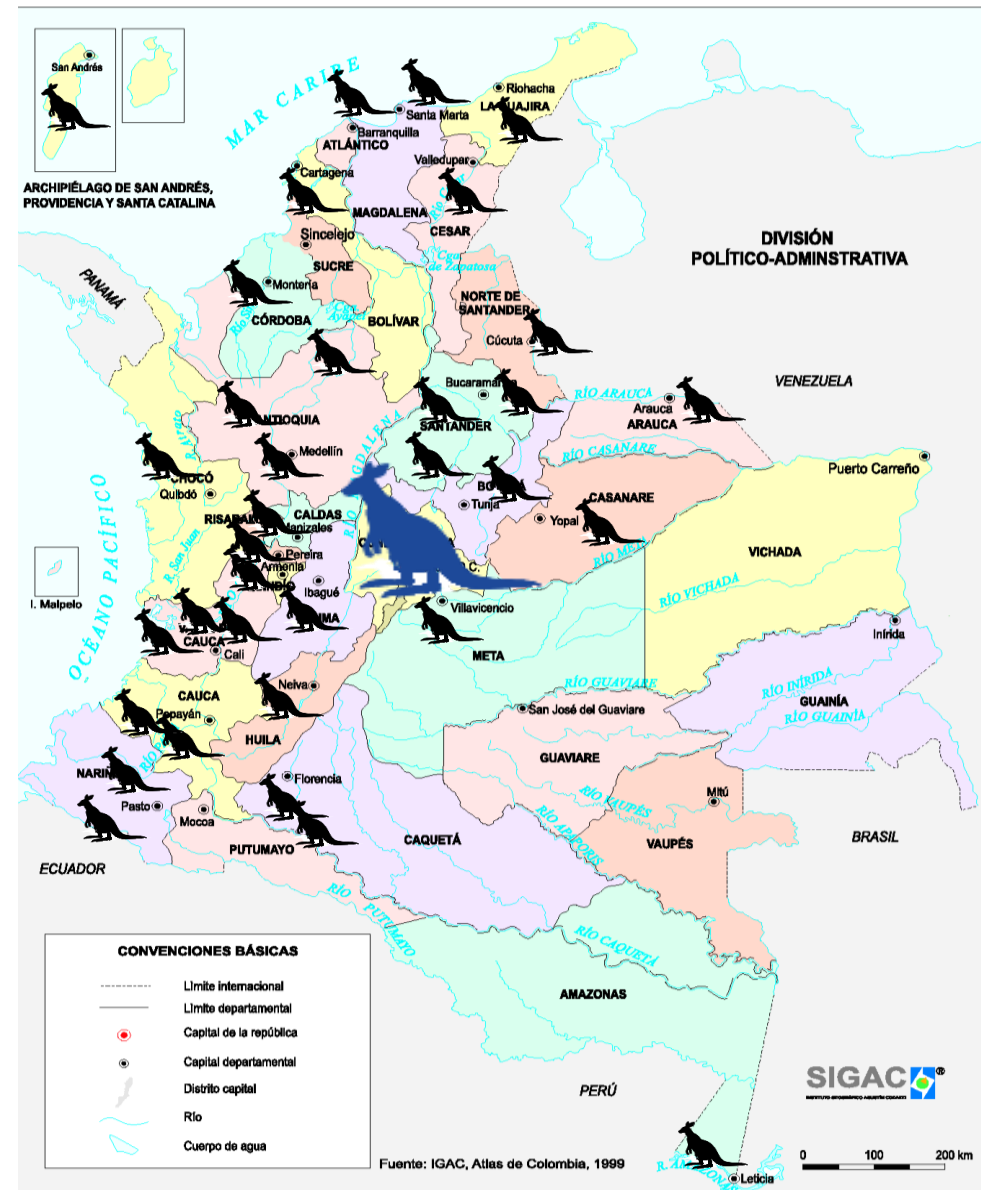
This dissemination model encourages health team leaders to collaborate with us, implement KMC in their institutions, and train their peers at strategic geographic locations within their region.



National Diffusion (2026)

There is a “kangaroo package” with a set price for activities during the first year of corrected age.

- There are 71 KMC Programs in 25 departments, which served 35,755 vulnerable children in 2025 (63% access).
- Public and private insurance companies must pay for the package containing the activities described in the official guidelines
- The value of the package is US\$ 900 up to one year of corrected age.



International Diffusion (1994-2026)

More than 216 teams from over 47 countries have received KMC training in Bogotá, Colombia.



Inpatient KMC



Outpatient KMC

2003

2022

método madre canguro

Guía práctica



Departamento de Salud Reproductiva e Investigaciones Conexas
Organización Mundial de la Salud
Ginebra

WHO recommendations for care of the preterm or low-birth-weight infant



World Health
Organization

Figure 1. Scope of WHO recommendations for care of the preterm or low-birth-weight infant

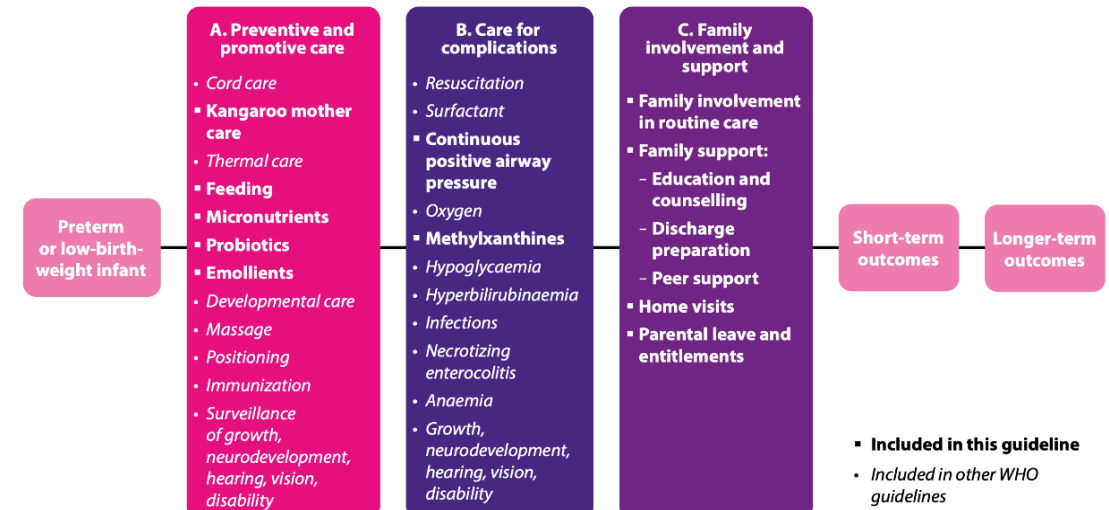


Table 1. WHO recommendations for the care of the preterm (< 37 weeks' gestation) or low-birth-weight (< 2.5 kg) infant

Domain	Recommendation	Status	Strength/type
A. PREVENTIVE AND PROMOTIVE CARE			
A.1a Any KMC	Kangaroo mother care (KMC) is recommended as routine care for all preterm or low-birth-weight infants. KMC can be initiated in the health-care facility or at home and should be given for 8–24 hours per day (as many hours as possible). (<i>Strong recommendation, high-certainty evidence</i>)	Updated	Strong
A.1b Immediate KMC	Kangaroo mother care (KMC) for preterm or low-birth-weight infants should be started as soon as possible after birth. (<i>Strong recommendation, high-certainty evidence</i>)	New	Strong

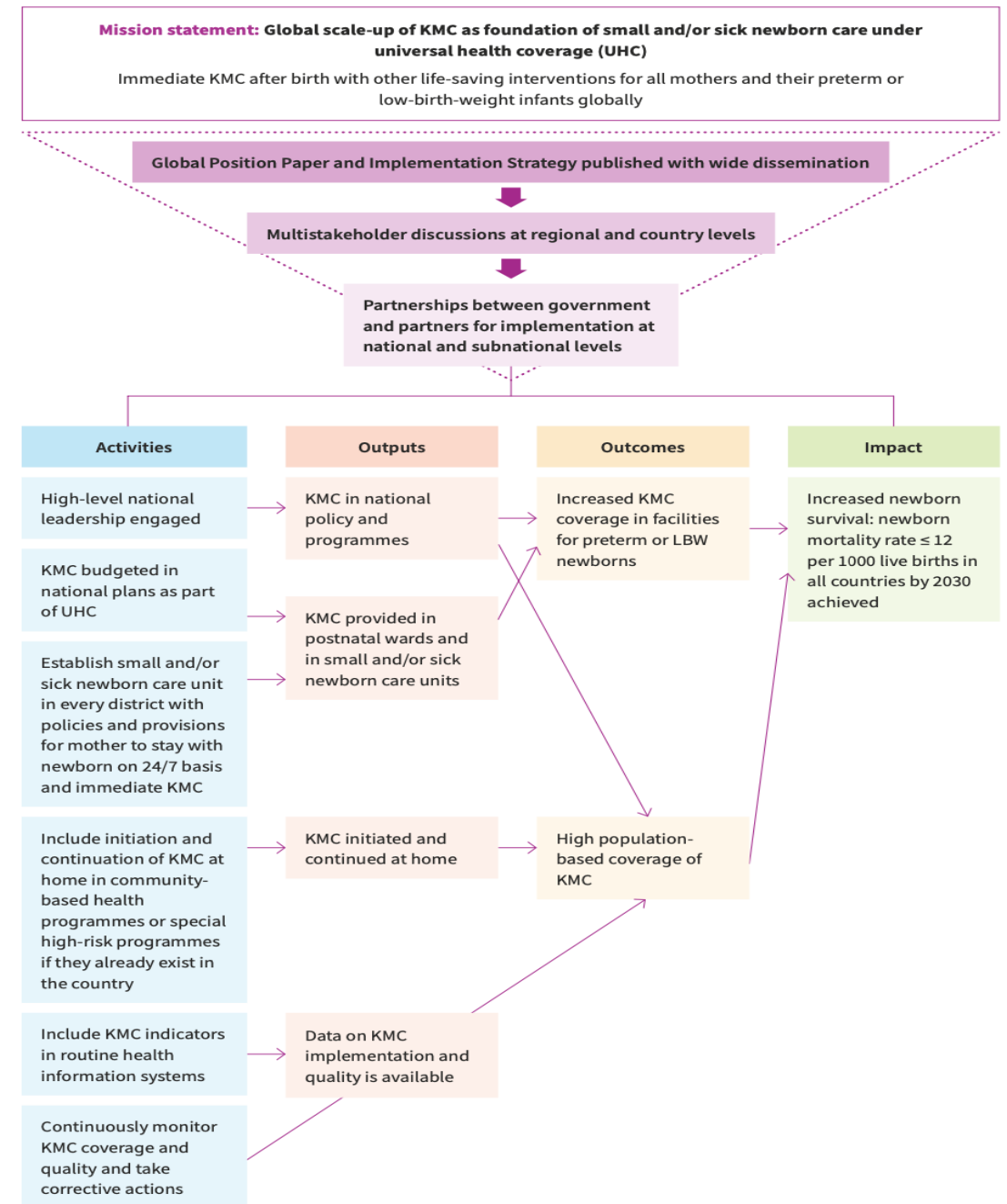
2023

Kangaroo mother care

Implementation strategy for scale-up adaptable to different country contexts



Figure 4. Theory of change



WHO position paper 2024



Implementing WHO's new recommendations will require a **change in the culture of health-care provision**. Crucially, this reorganization will involve moving away from obstetric and neonatal services that are typically organized in distinct departments with different treatment guidelines, providers, and locations towards **obstetricians, midwives, pediatricians, and neonatal nurses working together to provide care for mothers and newborn infants together in one place**, with families as key partners in the care of their newborn babies.



A major challenge will be changing the layout of maternal and neonatal units to **enable mothers to be with their sick preterm or LBW infants, who cared to be special for in special or intensive care units**. This change can be more readily achieved for preterm or LBW infants who are otherwise healthy, since they are usually cared for in the postnatal wards or separate KMC wards. However, even then, some reorganization is likely to be needed to accommodate fathers and other family members who can also provide KMC and help ensure infants receive KMC for as close to 24 h per day as possible.

Kangaroo mother care

A clinical practice guide



2025

The WHO practical guide from November 2025 builds on the paradigm shift that Kangaroo Mother Care (KMC) should be **initiated immediately after birth** for all preterm or low birth weight infants, even before they are stable.

Key highlights typically include:



Universal Application

KMC is now the standard of care for all small babies, moving away from “conventional” incubator care.



Zero Separation

Emphasizing the importance of keeping mother and baby together 24/7 to improve survival and long-term development.



Health System Integration

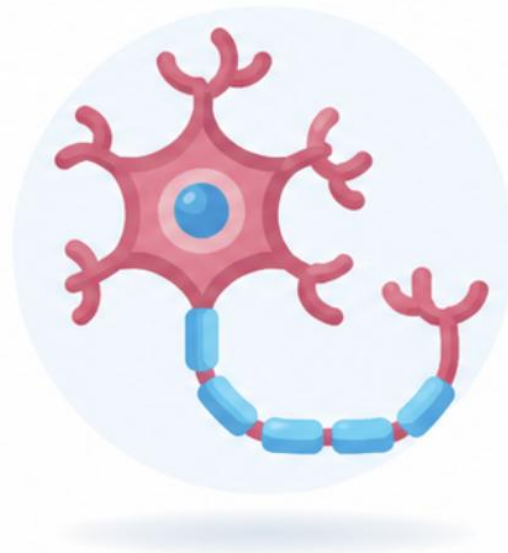
Guidelines on adapting Neonatal Intensive Care Units (NICUs) to accommodate mothers.

3.Exploratory results supporting the impact of KMC on brain growth and neurodevelopment



Key considerations for the premature brain

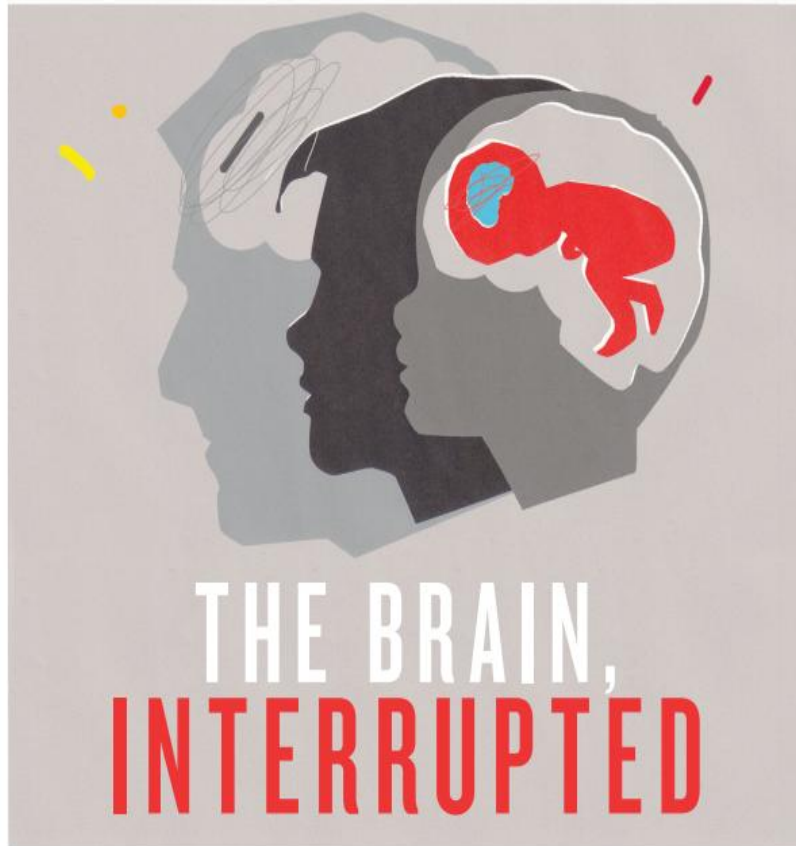
Prematurity, even in the absence of complications during the transition to extrauterine life, implies an alteration of brain organization and maturation.



Why are premature babies at greater risk of neurodevelopmental disorders?

NEWS FEATURE

By Alison Abbott *nature* | vol 518 | 5 February 2015

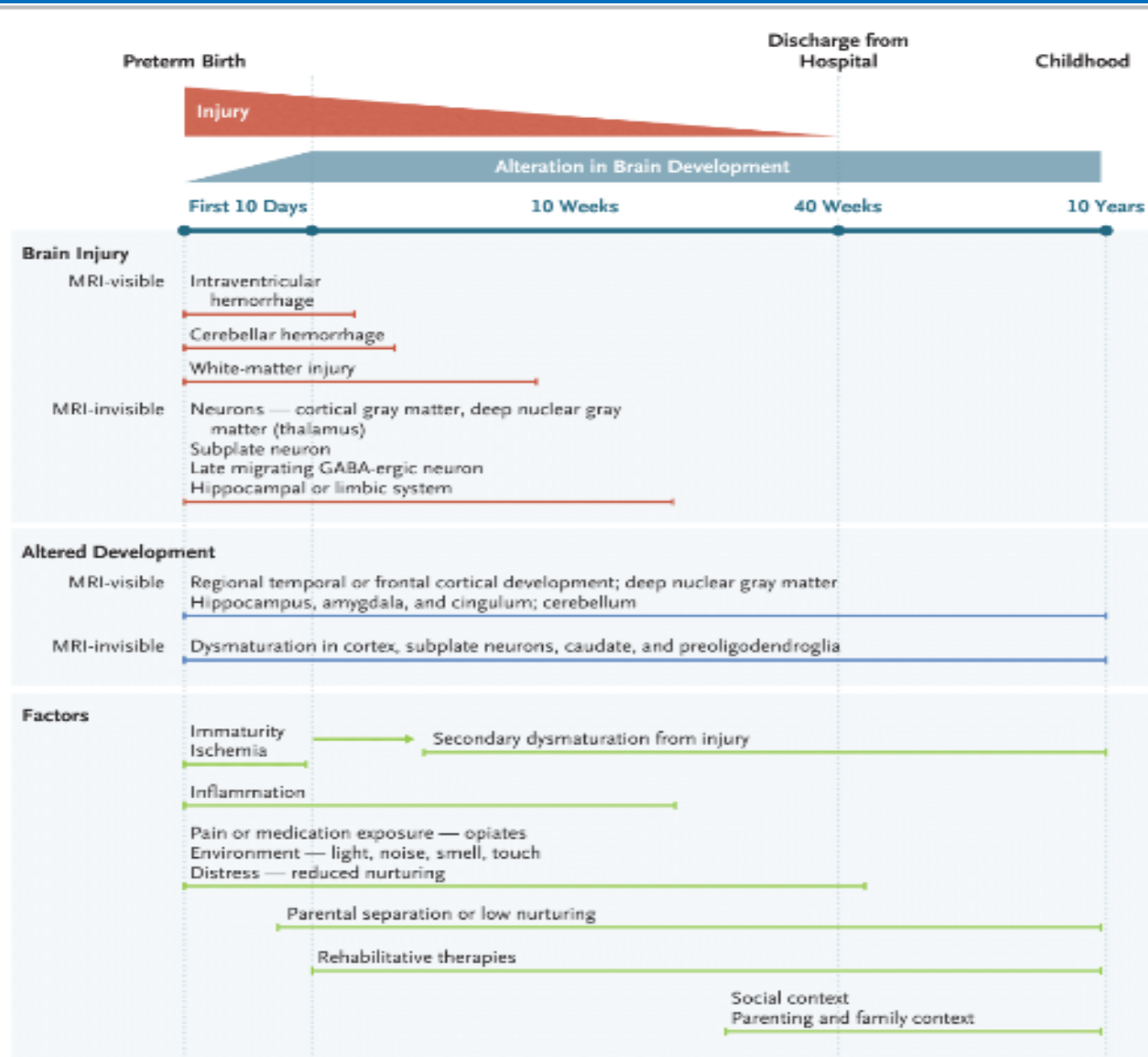


Courtesy A Lombo

Scientists suspect that when the brain is forced to carry out a crucial part of its development in the outside world, it receives inappropriate signals from the environment that affect the way its neurons are connected.

Compared to full-term babies, the neural pathways of premature babies are less well organized, often taking a more circuitous route. These organizational changes are correlated with reduced social and cognitive skills.

We need to better understand lesions of the developing brain



Defining the Neurologic Consequences of Preterm Birth

Terrie E. Inder, M.B., Ch.B., M.D., Joseph J. Volpe, M.D., and Peter J. Anderson, Ph.D.

NEJM 2023

Figure 1. Timeline of Vulnerability or Exposure and Neurologic Consequences of Preterm Birth.

Shown are the key timing, patterns, and factors determining the neurologic consequences of preterm birth. GABA denotes γ -aminobutyric acid, and MRI magnetic resonance imaging.

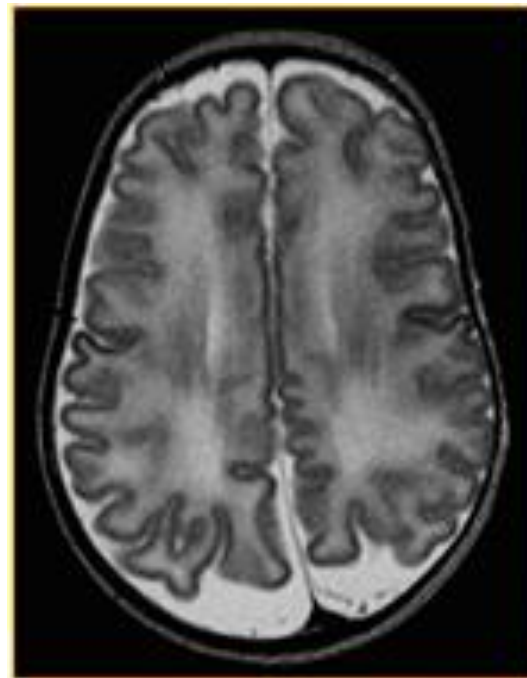
The problem of prematurity and where our responsibility lies.....

Brain of a premature baby compared to that of a full-term infant (Rueckert 2003).



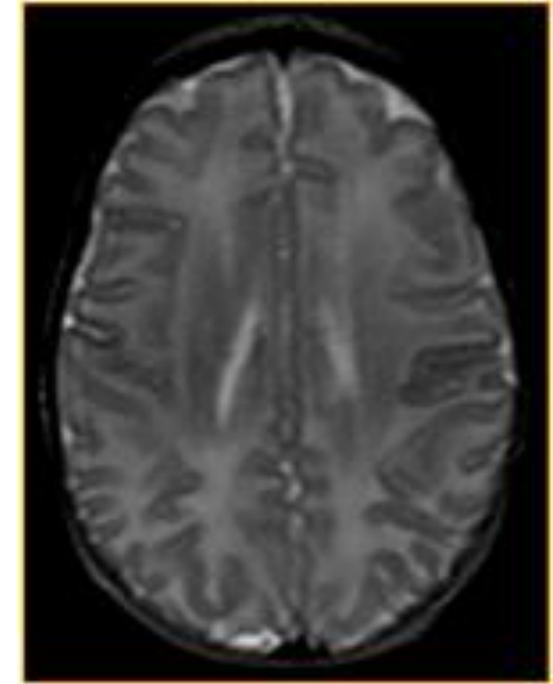
Preterm

Born at 25 weeks' GA
Brain at 25 weeks GA



Preterm

Born at 25 weeks' GA
Brain at 40 weeks' GA



Term

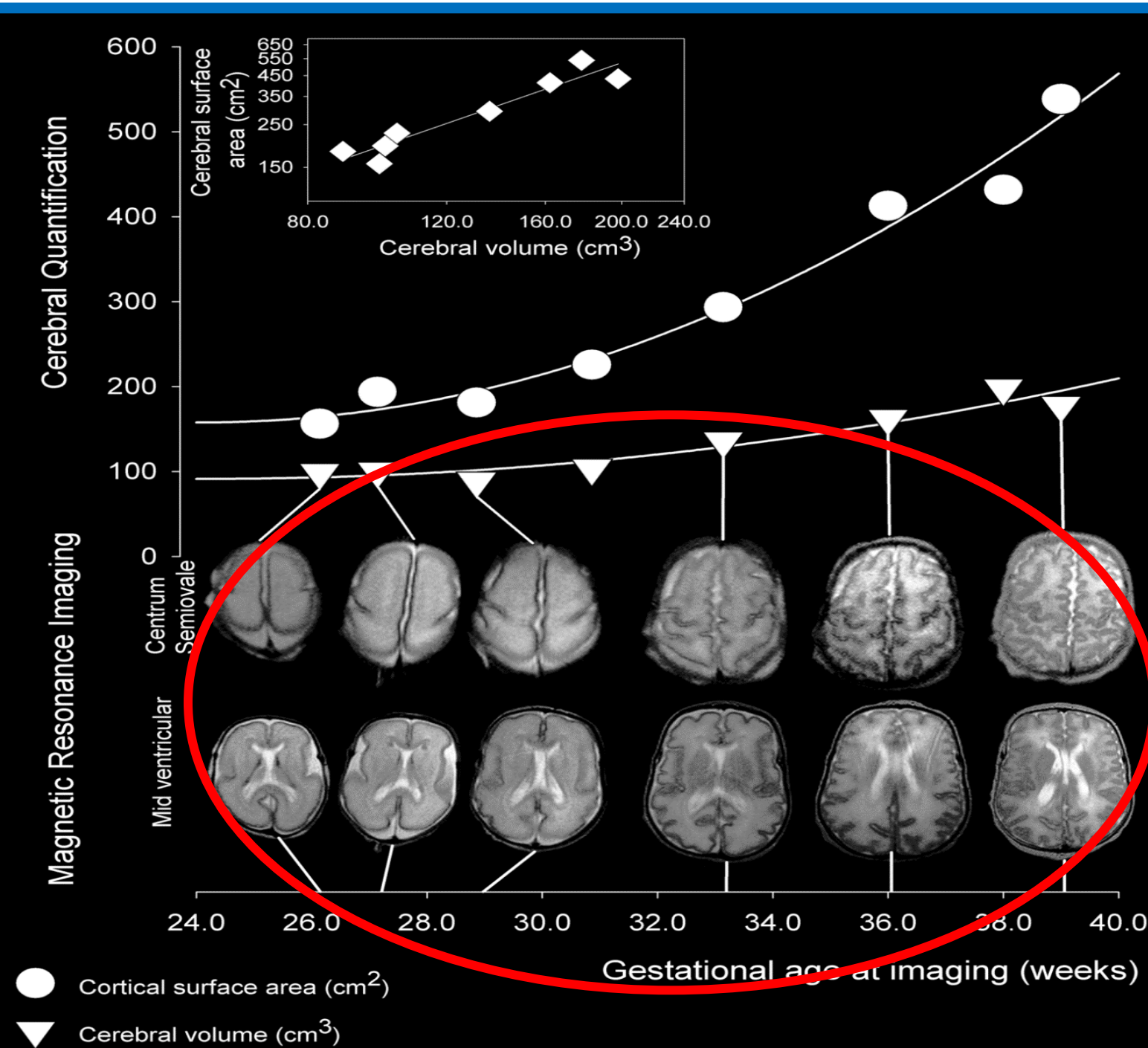
Born at 40 weeks' GA
Brain at 40 weeks' GA

Macroscopic evolution of the fetus brain during the last trimester

The brain grows in volume
(The cerebral volume is multiplied by x 1.5)

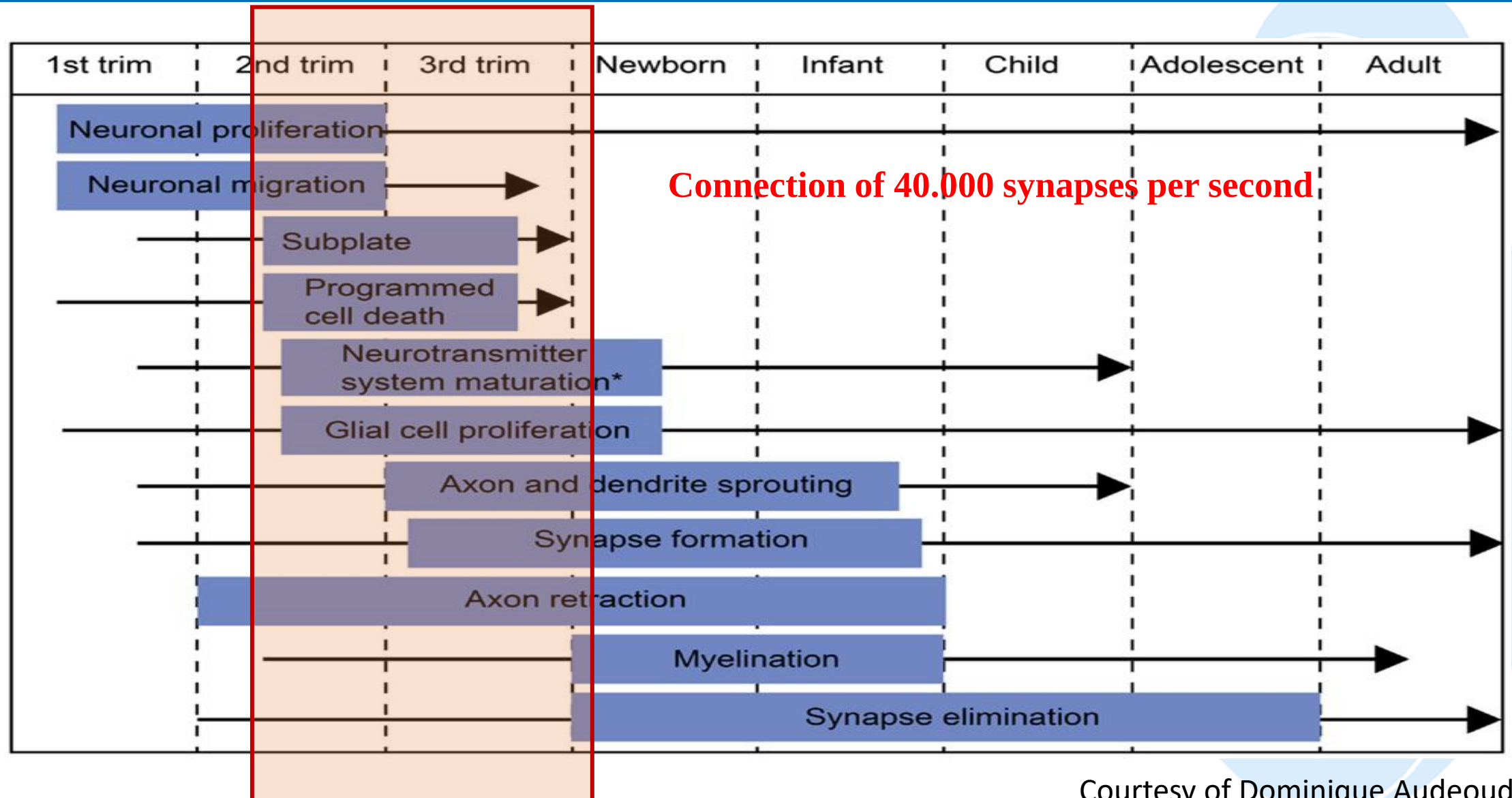
The cortex grows in surface (sulci and convolutions)

The surface of the cortex is multiplied by 4



Microscopic and functional evolution of the brain

Which impact nociceptive stimuli (sensory experiences) can have on the structure and function of a immature brain?



Interventions after birth should aim to create a **sensory-stimulating environment** for the **premature baby.**

An impoverished environment has been shown to **increase the risk of cognitive deficits.**



KMC and the immediate brain sensory stimuli

SENSORY COMPONENTS OF THE KMC		STIMULATED SENSE	
	Upward and downward movement of the maternal thorax		Vestibular stimulation
	Skin contact; heat		Tactile stimulation
	Body odor of parents, milk odor		Olfactory stimulation
	Maternal voice, breathing and heart sounds of the mother		Auditory stimulation
	Visual contact during the kangaroo position and breastfeeding		Visual stimulation
	Flexed and contained positioning		Proprioceptive stimulation

Olfaction in premature human newborn : detection and discrimination abilities two months before gestational term.

L Marlier, B Schaal, C Gaugler.
Chem Signals Vertebr 2001;9:205-9

The "smellscape" of mother's breast: effects of odor masking and selective unmasking on neonatal arousal, oral, and visual responses.

Doucet S, Soussignan R, Sagot P, Schaal B.
Dev Psychobiol. 2007 Mar;49(2):129-38.

The
Fetus
.....

Journal of Perinatology 2000; 20:S45-S54.

Robert Lickliter, PhD

Atypical Perinatal Sensory Stimulation and Early Perceptual Development: Insights From Developmental Psychobiology

Olfactory familiarization and discrimination in preterm and full term newborns

N Goubet ; C Rattaz, V Pierrat.
Infancy 2002;3:53-75

Olfactory experience mediates response to pain in preterm newborns.

N Goubet ; C Rattaz, V Pierrat
Dev Psychobiol 2003;42:171-80

Olfactory stimulation prevents apnea in premature newborns.

Marlier L, Gaugler C, Messer J.
Pediatrics. 2005 Jan;115(1):83-8.

KMC supports neurodevelopment through **3 mechanisms**:

CLOSER
CARE
BRIGHTER
FUTURES



1

Sensory stimulation

Mimicking in-utero experiences (e.g., heartbeat sounds, tactile input).



2

Stress reduction

Mitigating the adverse effects of neonatal intensive care unit (NICU) stress on brain plasticity.



3

Enhancing parent-infant bonding

Promoting emotional security and breastfeeding, which are linked to better cognitive outcomes.

Short- and medium-term benefits of KMC

Thermal regulation

Physiological stability

Pain and stress

Breastfeeding

Morbidity

Mortality

Apnea of prematurity

Somatic growth

Level of evidence
RCT of good

Strength

Free download of the material in the webpage of
the Fundación Kangourou/Kangaroo Foundation
www.fundacioncanguro.co



Received: 15 Oct
DOI: 10.1111

R

ACTA PEDIATRICA WILEY

uggest that Kangaroo
rematurity

Bohorquez³ | Nathalie Charpak^{1,2}

Accepted: 15 July 2020

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ACTA PEDIATRICA WILEY

atic review and meta-analysis suggest that the duration
Kangaroo mother care has a direct impact on neonatal
growth

Nathalie Charpak^{1,2} | Adriana Montealegre-Pomar^{1,2} | Adriana Bohorquez³

KMC short and medium term neurological impact?



"Neurophysiologic Assessment of Neonatal Sleep Organization: Preliminary Results of a Randomized, Controlled Trial of Skin Contact With Preterm Infants"

S.M. Ludington-Hoe, M.W. Johnson, K. Morgan, T. Lewis, J. Gutman, P. D. Wilson and M.S. Scher
Pediatrics 2006;117:e909-e923

Feldman R et al. Skin-to-Skin-contact(Kangaroo Care) promotes self-regulation in premature infants: sleep-wake cyclicity, arousal modulation, and sustained exploration. *Dev Psychol.* 2002 Mar;38(2):194-207

The KMC method seems to promote the neurological development in premature babies by improving:

- The organization of the baby's behavior,
- The sleep-wake cycles,
- The sleep quality
- and the maturation of neurological and psychomotor functions.

Level of evidence: observational studies, a few randomized clinical trials; but all the evidence points in the same direction.

Strength of recommendation A.

Bisanalli S et al. The beneficial effect of early and prolonged Kangaroo Mother Care on long-term neurodevelopmental outcomes in low birth weight neonates- A cohort study. *Acta Paediatr.* 2023 Aug 5.

Maternal-Preterm Skin-to-Skin Contact Enhances Child Physiologic Organization and Cognitive Control Across the First 10 Years of Life

Ruth Feldman^{a,*}, EFR Zohava Rosenblatt^a, Arthur J. Cohen^a

An analysis of the kangaroo care intervention using neonatal EEG complexity: A preliminary study

F. Kaffashi^{a,*}, M.S. Scher^b, S.M. Ludington-Hoe^c, K.A. Loparo^a

Clinical Neurophysiology 124 (2013) 238-246

^aDepartment of Electrical Engineering and Computer Science, Case Western Reserve University, Cleveland, OH 44106, United States

^bDepartment of Pediatrics, Case Western Reserve University, Cleveland, OH 44106, United States

^cSchool of Nursing, Case Western Reserve University, Cleveland, OH 44106, United States



Long-term effects of KMC on the brain?

Does KMC, whose short- and medium-term benefits are well documented, have **a long-term protective effect** against cognitive deficits and academic and social difficulties in young adult ex-preterm infants, modifying the microenvironment to which they are subjected during the neonatal period?



Effects of KMC on cerebral motor function at age 15

Pilot study with transcranial magnetic stimulation (2011)



Lab. neuro-
Stimulation et
Neurosciences
cliniques



Cyril Schneider¹, Ph.D., N.Charpak², MD, J.G.Ruiz³, MSc,
R.Tessier¹, PhD, J.T.Hernandez⁴, PhD

¹U.Laval, Quebec Canada, ²Fundacion Canguro, ³PUJ, ⁴U. de los Andes, Bogota, Colombia

ACTA PÆDIATRICA
NURTURING THE CHILD

Acta Pædiatrica ISSN 0803-

REGULAR ARTICLE

Cerebral motor function in very premature-at-birth adolescents: a brain stimulation exploration of kangaroo mother care effects

Cyril Schneider (cyril.schneider@rea.ulaval.ca)^{1,2}, Nathalie Charpak³, Juan G Ruiz-Peláez⁴, Réjean Tessier⁵

1.Clinical neuroscience and neurostimulation laboratory, Centre de recherche du CHUQ, Québec, QC, Canada

2.Department Rehabilitation, Faculty of Medicine, Université Laval, Québec, QC, Canada

3.Kangaroo Foundation, Bogotá, DC, Colombia

4.Department Clinical Epidemiology and Biostatistics, Faculty of Medicine, Javeriana University, Bogotá, DC, Colombia

5.School of Psychology, Centre de recherche du CHUQ et CIRRS Université Laval, Québec, QC, Canada

Hemispheric and transcallosal circuits function better in adolescents who have been exposed to KMC during the neonatal period. It seems that KMC applied at an opportune time could stimulate brain connectivity and synaptic efficacy.



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**Randomized, open-label, controlled trial
comparing the KMC method vs. traditional
approach for LBW infants: A cross-sectional,
patient-centered study conducted at ages
18-20 years.**

Coordinator: Kangaroo Foundation Bogota, Colombia

Here are some
new results of
exploratory
analyses of our
neuroimages
data set



IOWA STATE
UNIVERSITY



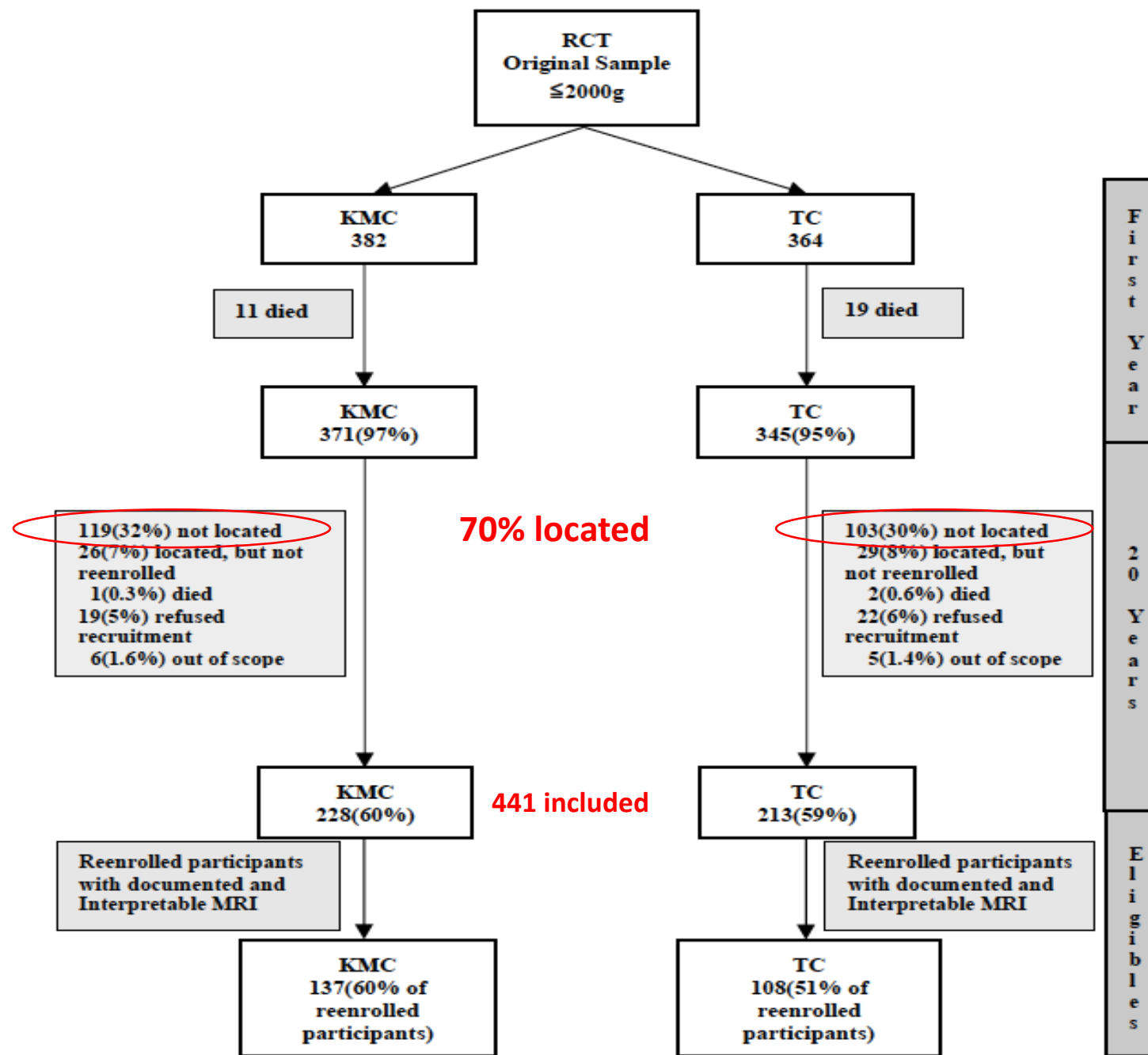


Figure 1. Flow Chart: Reenrolled Cohort for Imaging.

Summary of the Battery of test performed between birth up to 20 years of age

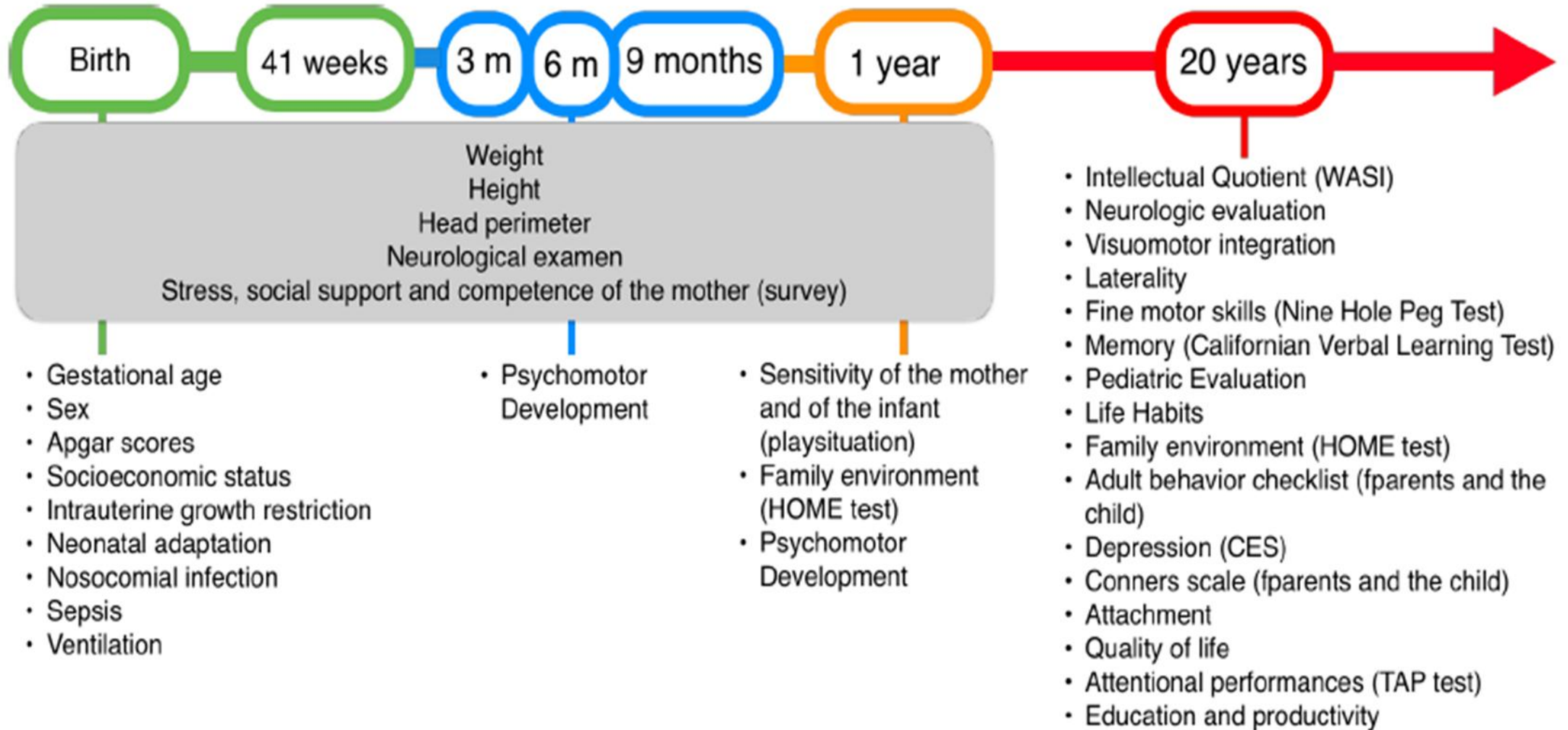


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Twenty-year Follow-up of Kangaroo Mother Care Versus Traditional Care

Nathalie Charpak, Rejean Tessier, Juan G. Ruiz, Jose Tiberio Hernandez, Felipe Uriza, Julieta Villegas, Line Nadeau, Catherine Mercier, Francoise Maheu, Jorge Marin, Darwin Cortes, Juan Miquel Gallego, Dario Maldonado

Early Childhood Interventions and Parental Investments: The Long-run Effect of the Kangaroo Mother Care Program (KMC) on Cognitive and Socioemotional Skills

Orazio Attanasio¹, Darwin Cortes², Juan Gallego², Dario Maldonado³, Paul Rodriguez², Nathalie Charpak⁴, Rejean Tessier⁵, Juan Gabriel Ruiz⁶, Tiberio Hernandez⁷, and Felipe Uriza⁶

¹Economics Department, University College of London, UK

²Economics Department, Rosario University, Colombia.

³Government School, Andes University, Colombia

⁴Pediatrician, Director, Kangaroo Foundation, Colombia

⁵CRDH, Université de Laval, Canada

⁶Hospital San Ignacio - Universidad Javeriana, Colombia

⁷IMAGINE Team, Systems & Computing Engineering, Andes University, Colombia



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Digital Object Identifier 10.1109/ACCESS.2023.3259972

RESEARCH ARTICLE

VALS: Supporting Visual Data Analysis Longitudinal Clinical Studies

DUVÁN A. GÓMEZ^{1,2}, (Member, IEEE), NATHALIE CHARPAK³, ADRIANA AND JOSÉ TIBERIO HERNÁNDEZ^{4,1,3}

¹Department of Systems and Computing Engineering, Universidad de los Andes, Bogotá, Capital District 111711, Colombia

²School of Engineering and Basic Sciences, Universidad EIA, Envigado, Antioquia 055428, Colombia

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⁴Medicine Faculty, Javeriana University, Bogotá, Capital District 110231, Colombia

Corresponding author: Duván A. Gómez (da.gomez16@uniandes.edu.co)

This work involved human subjects or animals in its research. Approval of all ethical and experimental procedures and protocols was granted by the Ethical Committee from the School of Medicine of Universidad Javeriana (Bogotá, Colombia) and Fundación Santafé de Bogotá (Bogotá, Colombia).

ABSTRACT Visual data analysis helps to understand different types of phenomena to explore for relationships, patterns, outliers, unexpected changes, and more. Exploratory data analysis helps them find useful and actionable information in the data so that they can test their hypotheses and discover new ones. This need becomes more evident in longitudinal studies, where there are many variables and the process being analyzed can be complex as well. We present VALS (Visual Analysis Longitudinal Studies), a framework for visually exploring longitudinal clinical data. VALS includes a data model, a task categorization model, and an approach to guidance through feature exploration and interactive visualizations, all of which help analysts perform their analysis tasks in collaboration with healthcare experts with experience in longitudinal studies. We present a tool prototype for a case study using real-world datasets. The evidence collected in this study shows the usefulness of a VALS-based visual analytics tool.



Scioteca / 06. Documentos de trabajo / 6.1 Documentos de trabajo

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Materias

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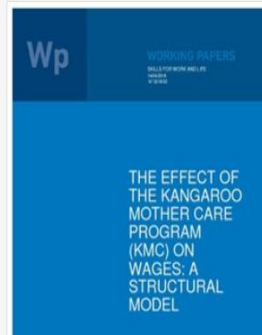
Autores

Títulos

Materias

The Effect of the Kangaroo Mother Care Program (KMC) on Wages: A Structural Model

In this paper we analyze the relationship between skills and some outcomes later in life for a population of premature children. Pretreatment skills and characteristics are good predictors of childhood and adulthood skills and outcomes. Income per capita and parents education at birth are positively correlated with home environment at 6 and 12 months of corrected age. Moreover, parents education and the proportion of workers at home are correlated with the number of preschool years attended by children. Interestingly, health indicators taken during the first year of life are critical factors for decision to enroll into a university, to obtain better results in math scores and earn larger wages.



ORIGINAL ARTICLE | Open Access |

Kangaroo mother care had a protective effect on the volume of brain structures in young adults born preterm

Nathalie Charpak , Réjean Tessier, Juan Gabriel Ruiz, Felipe Uriza, José Tiberio Hernandez, Darwin Cortes, Adriana Montealegre-Pomar

First published: 24 January 2022 | <https://doi.org/10.1111/apa.16265> | Citations: 12

Funding information

Grand Challenge Canada.

SECTIONS

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TECHNOLOGY REPORT article

Front. Neuroinform., 23 August 2016 | <https://doi.org/10.3389/fninf.2016.00036>



A Multi-faceted Visual Analytics Tool for Exploratory Analysis of Human Brain and Function Datasets

Diego A. Angulo^{1*}, Cyril Schneider², James H. Oliver³, Nathalie Charpak⁴ and Jose T. Hernandez¹

¹IMAGINE, Systems and Computing Engineering, Universidad de los Andes, Bogotá, Colombia

²LCNS, CHUL, Quebec, QC, Canada

³VRAC, Iowa State University, Ames, IA, USA

⁴Kangaroo Foundation, Bogotá, Colombia



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Articles

The long-term effects of the Kangaroo Mother Care intervention on cognitive functioning: Results from a longitudinal study

Stéphanie Ropars, Réjean Tessier , Nathalie Charpak & Luis Felipe Uriza

Pages 82-91 | Published online: 29 Jan 2018

Download citation <https://doi.org/10.1080/87565641.2017.1422507>

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Early Human Development

Volume 110, July 2017, Pages 44-49



Long-term attention deficits combined with subcortical and cortical structural central nervous system alterations in young adults born small for gestational age

Sabrina Suffren ^a, Diego Angulo ^{b, c, d}, Yang Ding ^a, Pablo Reyes ^{c, e}, Jorge Marin ^f, Jose T. Hernandez ^d, Nathalie Charpak ^c, Gregory A. Lodygensky ^{a, g, h, i}

Journal of neonatology, Invited paper |

Title:

KMC and brain development: A plea for starting KMC as early as possible and as long as possible

Authors: Nathalie Charpak, MD ^{a, b}, Catalina Lince-Rivera, MD ^{a, c}, J.T. Hernandez Eng, MSc, PhD ^a
Institutional Affiliations: ^a Kangaroo Foundation, ^b Pontificia Universidad Javeriana, ^c Hospital Universitario San Ignacio Bogotá, Colombia

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ORCID Dr. Lince-Rivera: 0000-0002-4293-6822.

ORCID Dr. Hernandez: 0000-0002-5035-4363

Mortality

Age	Kangaroo N/total	Control N/total	Mortality RR in the co (95%CI) ¹
Term	6/364 (1.6%)	10/345 (2.9%)	1.76 (0.65-4.1)
3 months of CA	7/350 (2.0%)	16/343 (4.7%)	2.33 (0.97-5.6)
6 months of CA	10/350 (2.8%)	18/343 (5.2%)	1.84 (0.86-3.5)
9 months of CA	10/350 (2.8%)	19/343 (5.5%)	1.94 (0.91-4.1)
12 months of CA	11/350 (3.0%)	19/343 (5.5%)	1.76 (0.85-3.6)
20 years	12/382 (3.14%)	21/364 (5.77%)	1.84 (0.93-3.6)

¹ 95% Confidence interval
² P=0.058

KMC (N/Total) Less than 1800g	Control (N/Total) Less than 1800g	OR (95% CI)
8/229 (3.5%)	16/204 (7.7%)	0.42 (0.18-1.02)
After adjusting for birth weight and gestational age: Protective effect of KMC → OR 0.42 (0.16-0.94) P=0.04		

Paternal support

- We constructed a variable to assess paternal support that included all aspects of the father's involvement in infant care during the first year follow-up.
- This variable had a positive impact on the home environment at 1 year of corrected age (CA).
- Paternal support at 1 year of CE was dependent on whether the father carried in Kangaroo Position (KP) during the neonatal period.

There is a strong relationship between paternal stability 20 years later (paternal support score in parents, 15.3 vs. 14.6 in separated families)



Schooling,
productivity,
academic results
and working life

Social behavior according to parents' perspective and mother's level of education

Mother's level of education	KMC		Control		P		
	Low-level	Upper level, average (SD)	Low level average, (SD)	Upper level, average (SD)	KMC vs control	Mother's level of education	Interaction between mother's education level and intervention.
Conners hyperactivity, average (SD)	62 (10)	65 (15)	74 (14)	60 (14)	0.15	0.01	0.00
Conners' aggressiveness, mean (SD)	54 (12)	54 (11)	64 (15)	53 (11)	0.03	0.00	0.00
ABCL DSM DSM antisocial, mean (SD)	69 (16)	71 (14)	78 (14)	68 (16)	0.29	0.09	0.02
Internalization of DSM ABCL, mean (SD)	72 (26)	74 (24)	82 (16)	74 (22)	0.23	0.42	0.18
ABCL DSM Externalization, mean (SD)	63 (24)	64 (22)	79 (16)	62 (23)	0.09	0.03	0.00

Repeated measures of IQ and environmental quality at 6 and 12 months and 20 years, according to neurological examination at 6 months (proxy for child's fragility at birth) (≤ 1800 g)

Measure	KMC		Control		P		
	Normal	Transient or abnormal	Normal	Transient or abnormal	KMC vs control	Neurological status	Interaction between neurological status and intervention
IQ at 6 months, Average (SD)	98.1 (10.0)	90.0 (13.4)	99.5 (9.2)	84.5 (12.6)	0.23	0.00	0.03
IQ at 12 months, Average (SD)	103.4 (6.6)	99.4 (8.8)	103.0 (6.7)	94.6 (10.2)			
IQ at 20 years, Average (SD)	87.2 (13.1)	90.2 (14.9)	89.9 (14.9)	87.0 (12.7)			
Home at 12 months, Average (SD)	39.3 (6.8)	39.9 (5.5)	39.7 (7.5)	35.5 (8.0)	0.11	0.12	0.02
Home at 20 years, Average (SD)	39.5 (7.3)	40.5 (6.0)	40.7 (6.6)	36.6 (5.4)			

Variable	KMC (n=139)	Control (n=125)	Difference	P-value
Years of preschool, average (SD)	2.52 (1.07)	2.05 (1.04)	0.47 (0.14)	0.00
School absenteeism, average (SD)	0.07 (0.26)	0.17 (0.37)	-0.09 (0.04)	0.01

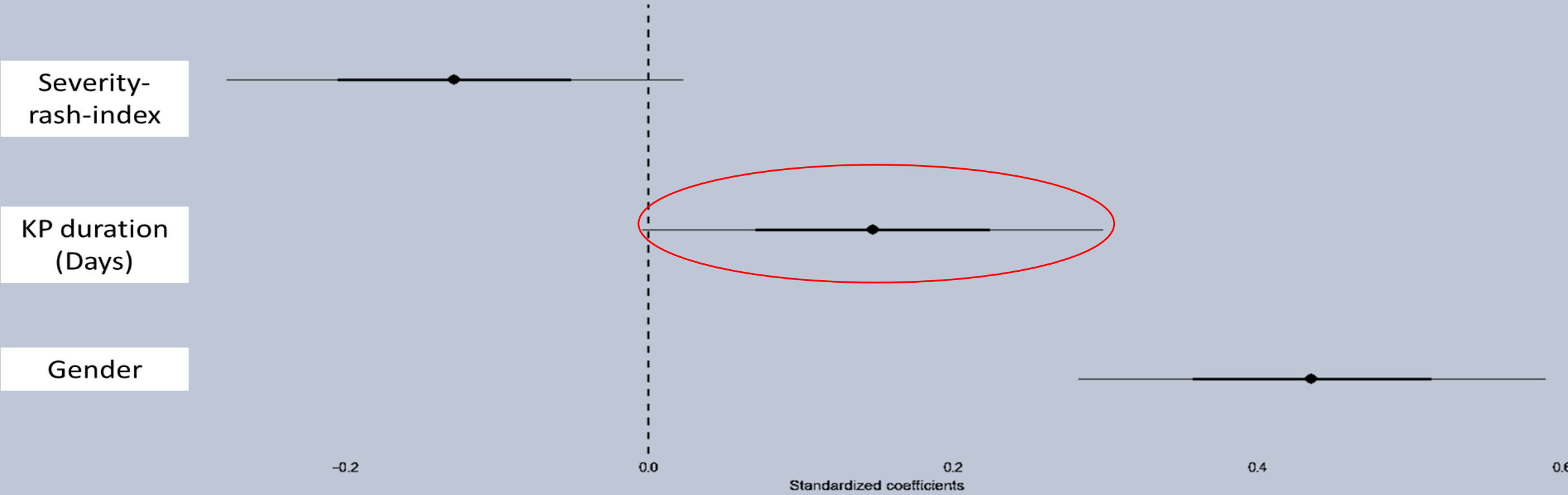
Persistence, in the cohort recovered at 20 years, of the effects observed in the original cohort at 12 months corrected age

Results at 1 year corrected age	20 years old and Median IQ < 90	20 years old and Median IQ $\geq$ 90	p (Mann-Whitney)
Factor score for weight gain during the first year of corrected age (median)	- 0.11	0.19	0.008
Factor score of height gain during the first year of corrected age (median).	- 0.03	0.21	0.002
Factor score of head circumference increase during the first year of corrected age (median).	- 0.20	0.08	0.001
Head circumference at one year of age corrected by the 50th percentile of the expected head circumference for age and sex x 100 (%)	96.5	98.1	0.000 ^a
Maternal sense of competence (median)			
At 41 weeks	- 0.10	- 0.09	0.26 ^b
At one year of corrected age	- 0.29	- 0.15	0.063
HOME Test at 1 year of age corrected (median)	38	41	0.000
Cognitive stimulation subscale of the family	4	5	0.000
Mother's emotional restrictions subscale	- 13	- 13	0.002
Open family	9	10	0.002
Structured environment	6	6	0.042 ^c

Impact of KMC on brain volumes and structures

Group allocation		Volumen cortex izquierdo	Volumen cortex derecho	Volumen cortex total	Volumen Gray Matter
1 KMC	Mean	216494	217362	433856	571762
	N	115	115	115	115
	Std. Deviation	26904	26874	53537	62041
2 Control	Mean	207926	208441	416367	552237
	N	98	98	98	98
	Std. Deviation	29598	28704	58062	65850
P value		0.03	0.02	0.02	0.03

Correlation between total cortical gray matter volume at 20 years and duration of kangaroo position in infants hospitalized during the neonatal period



Coefficients:

Coefficient	Slope	T Value	P Value
Intercept	0.000000	0.000000	1.000000
Gender	0.435396	5.614372	0.000000
KP duration (Days)	0.146802	1.924735	0.056366
Severity	-0.127854	-1.687733	0.093771

$R^2 = 0.21$ $F(3,135) = 13.53$ $P = 0.000000$

Factor Plot

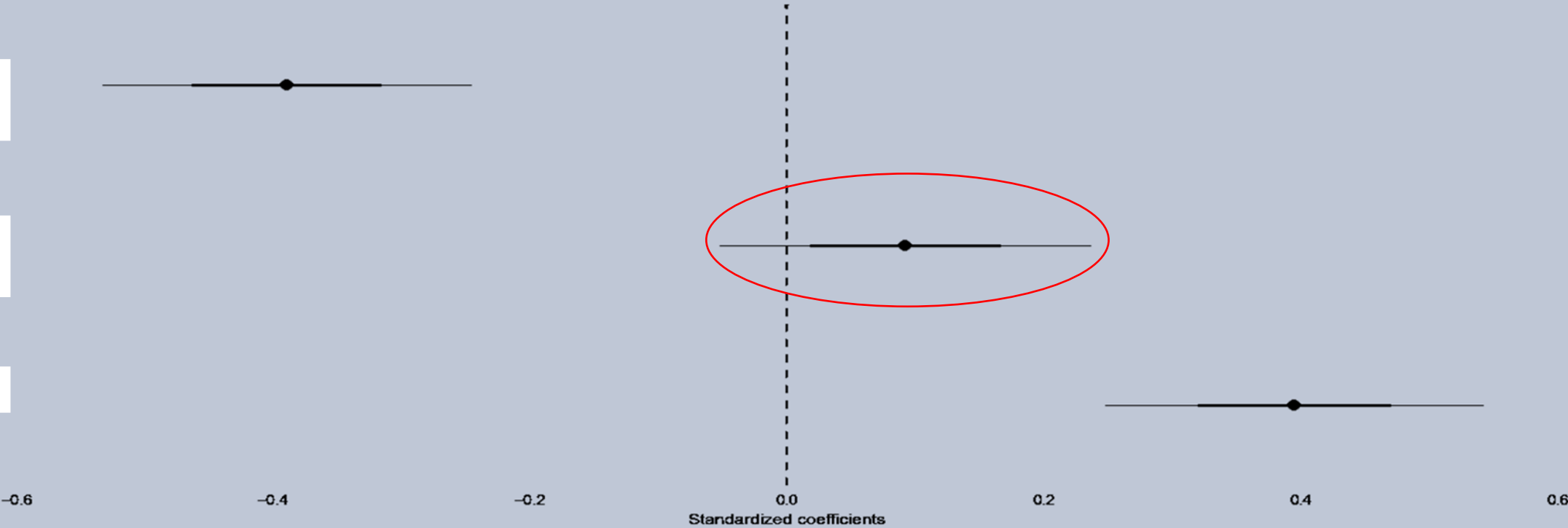
Residuals Plot

Correlation between total subcortical gray matter volume at 20 years and duration of kangaroo position in infants hospitalized during the neonatal period

Severity-rash-index

KP duration (Days)

Gender



Coefficients:

Coefficient	Slope	T Value	P Value
Intercept		0.000000	1.000000
Gender		5.314350	0.000000
KP duration (Days)		1.257634	0.210695
Severity		-5.378303	0.000000

R² = 0.28

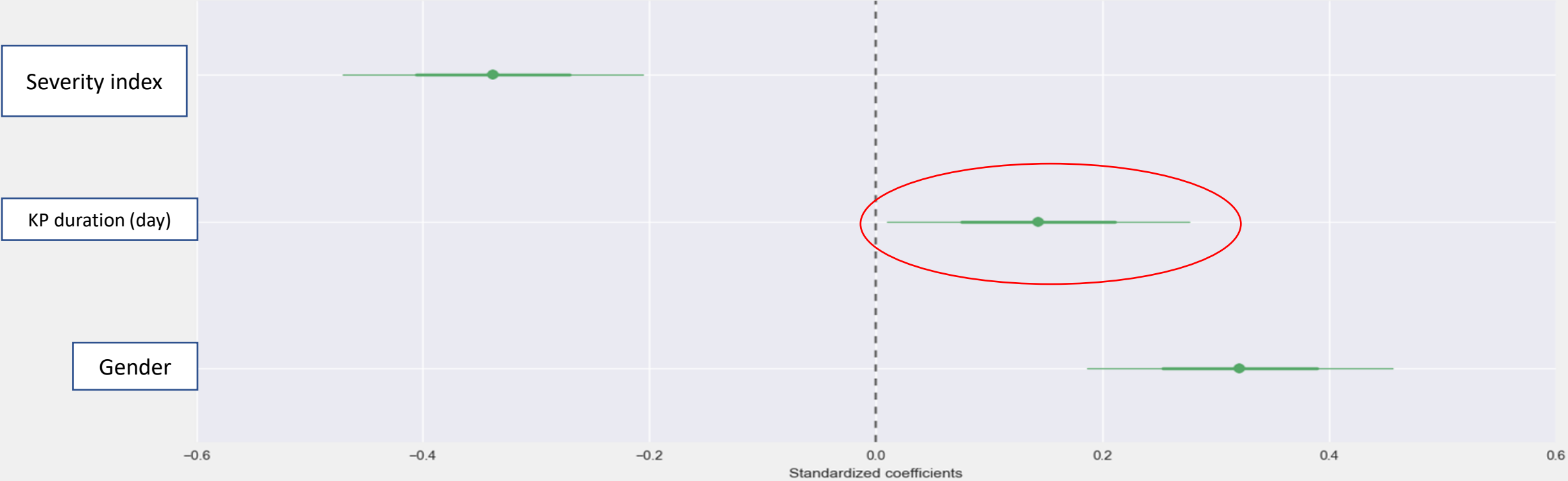
F(3,135) = 18.90

P = 0.000000

Factor Plot

Residuals Plot

Striatum volume at 20 years and duration of the kangaroo position



Coefficients:

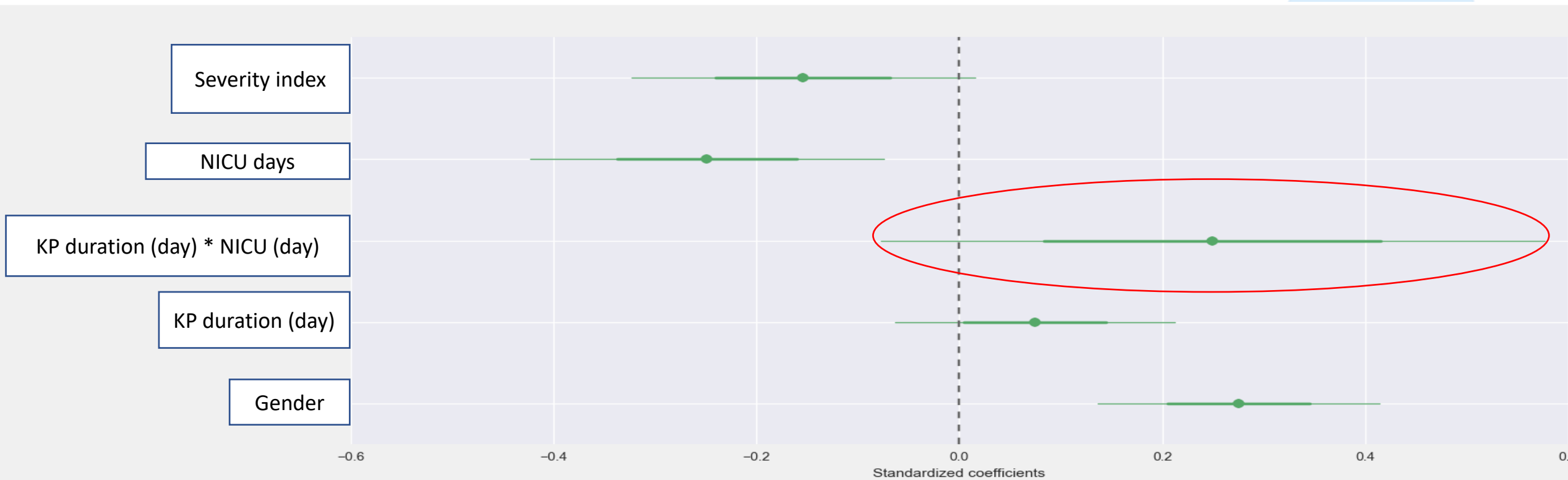
Coefficient	Slope	T Value	P Value
(Intercept)	0.000000	0.000000	1.000000
BIRTH_sex05	0.320972	4.691683	0.000005
EX41_durPCconcontrols03	0.142732	2.110826	0.036216
Fragility_Rasch_441_2PL	-0.338240	-5.030050	0.000001

$R^2 = 0.21$

$F(3,174) = 16.61$

$P = 0.000000$

Hippocampal volume at 20 years, days in NICU (proxy for stress) and Duration of the Kangaroo Position



Coefficients:

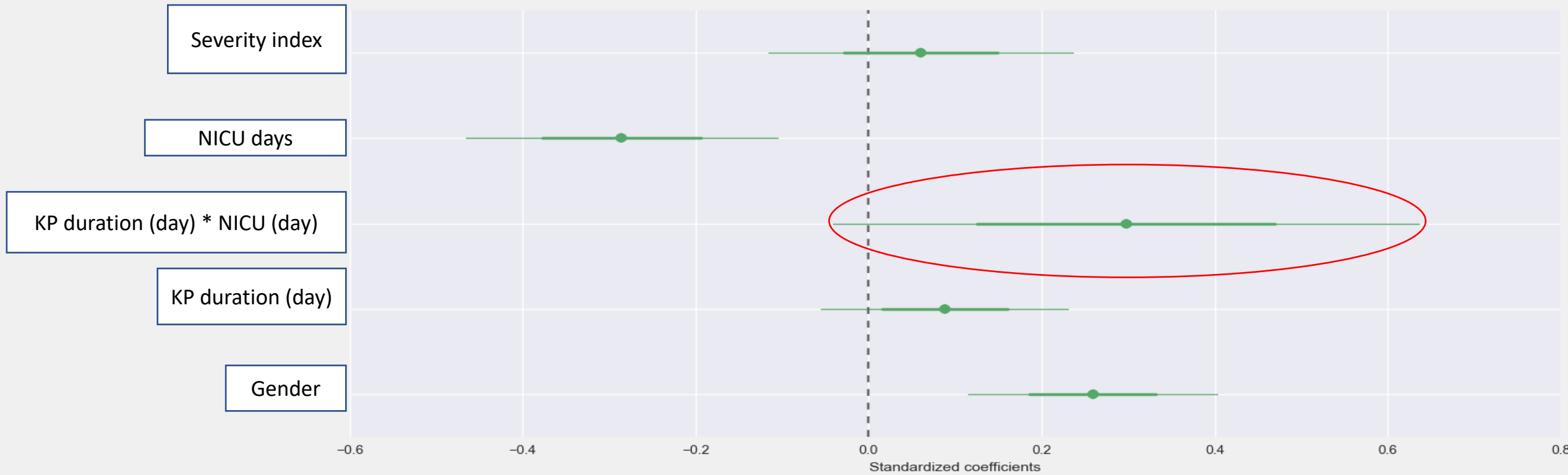
Coefficient	Slope	T Value	P Value
BIRTH_sex05	0.275366	3.915262	0.000130
EX41_durPCconcontrols03	0.074896	1.073238	0.284668
EX41_durPCconcontrols03*FOLLOW_diasuci02	0.249807	1.507017	0.133641
FOLLOW_diasuci02	-0.248548	-2.819724	0.005371
Fragility_Rasch_441_2PL	-0.153938	-1.793177	0.074702

$R^2 = 0.17$

$F(5,172) = 8.03$

$P = 0.000001$

Amigdala volume at 20 years, days in NICU and the duration of the Kangaroo position



Coefficients:

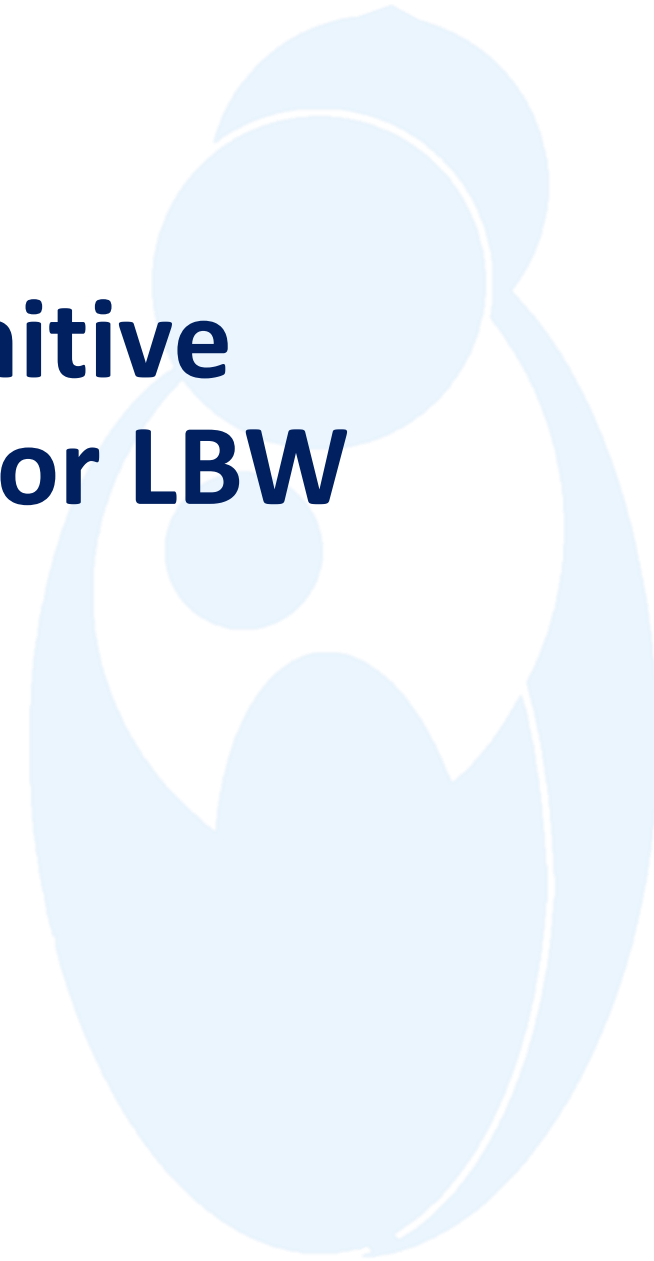
Coefficient	Slope	T Value	P Value
BIRTH_sex05	0.258719	3.552776	0.000492
EX41_durPCconcontroles03	0.087650	1.213049	0.226774
EX41_durPCconcontroles03*FOLLOW_diasuci02	0.297270	1.732021	0.085063
FOLLOW_diasuci02	-0.285610	-3.129381	0.002058
Fragility_Rasch_441_2PL	0.060094	0.676075	0.499901

$R^2 = 0.11$

$F(5,172) = 5.17$

$P = 0.000189$

Brain volumes, KMC and cognitive development of the premature or LBW infant



Evaluated on the observation of cognitive performance with the **WASI** test

Verbal comprehension (VCI)

- Vocabulary measure word knowledge and verbal concept formation
- Similarities measure verbal concept formation and reasoning

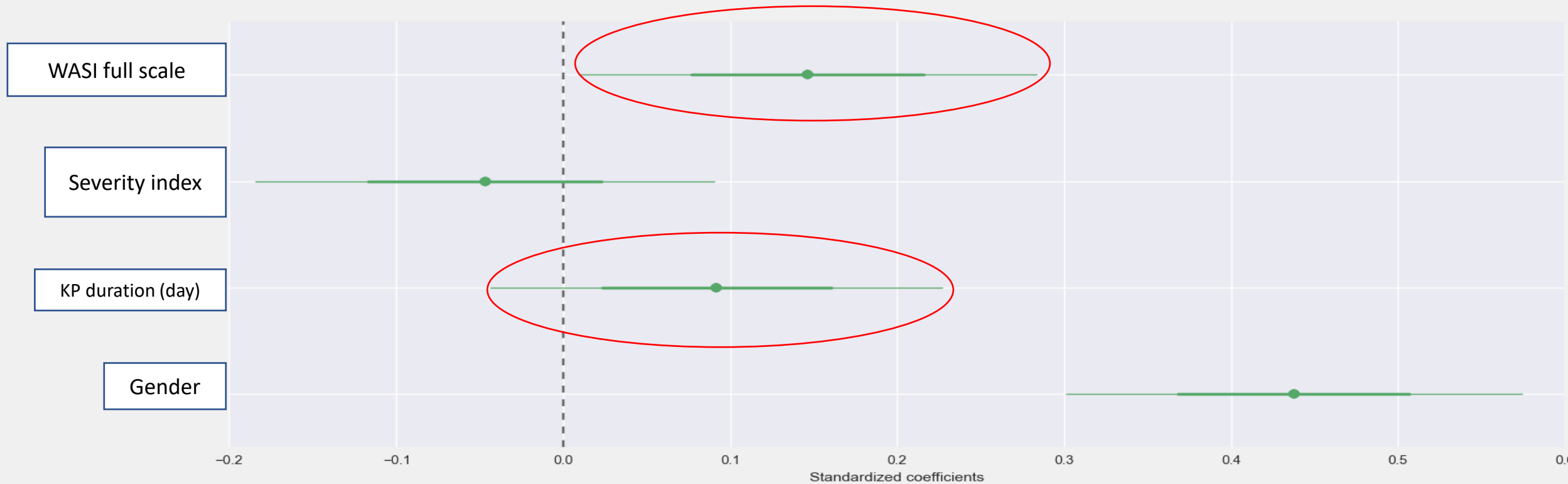
Perceptual reasoning (PRI)

- Block design measure the ability to analyze and synthesize abstract visual stimuli
- Matrix reasoning measure fluid intelligence, broad visual intelligence, classification and spatial ability, knowledge

Rimol, L. M., Rise, H. H., Evensen, K. A. I., Yendiki, A., Løhaugen, G. C., Indredavik, M. S., ... & Skranes, J. (2023). Atypical brain structure mediates reduced IQ in young adults born preterm with very low birth weight. *Neuroimage*, 266, 119816.

Inder, T. E., Volpe, J. J., & Anderson, P. J. (2023). Defining the neurologic consequences of preterm birth. *New England Journal of Medicine*, 389(5), 441-453.

Volume of the cortical gray matter at 20 years, WASI test (intellectual quotient) and duration of the kangaroo position



Coefficients:

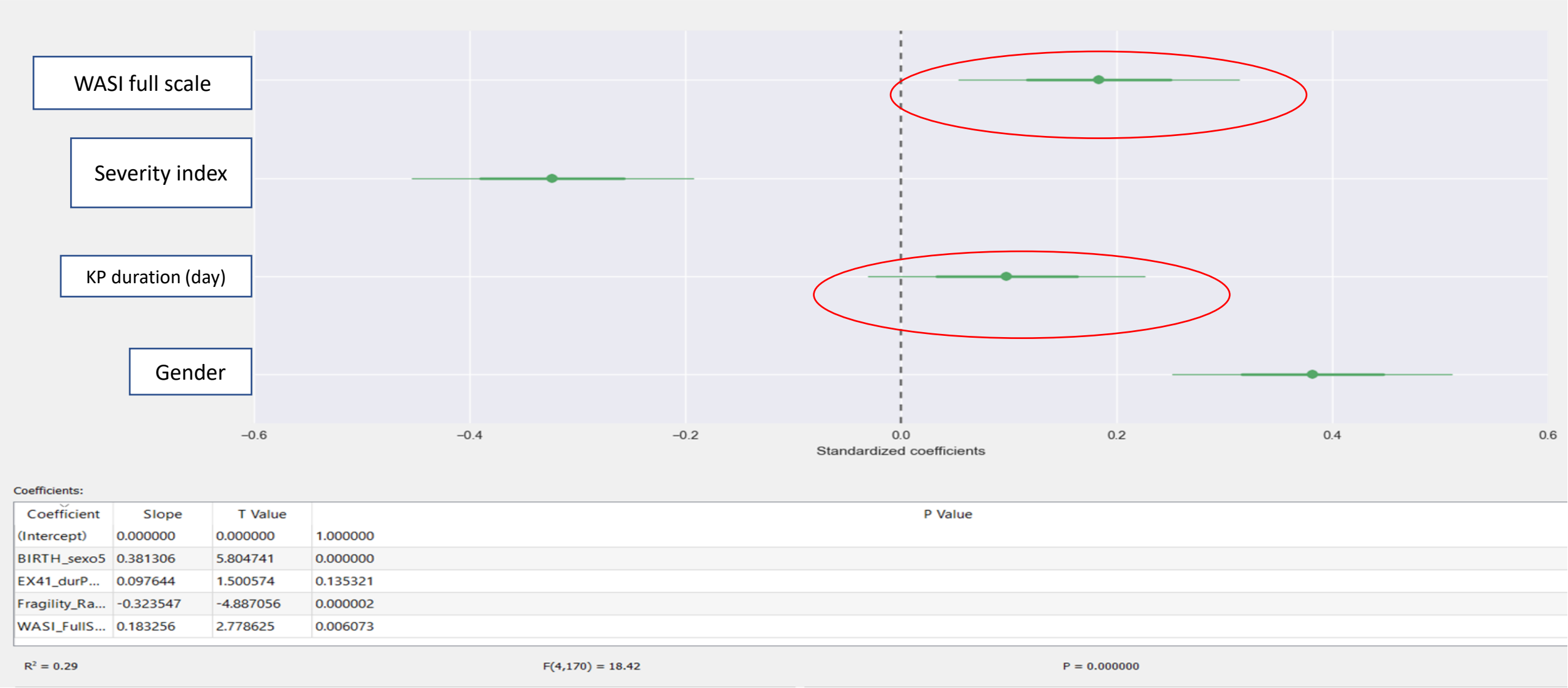
Coefficient	Slope	T Value	P Value
(Intercept)	-0.000000	-0.000000	1.000000
BIRTH_sex05	0.437698	6.333092	0.000000
EX41_durPCconcontrols03	0.091874	1.341953	0.181401
Fragility_Rasch_441_2PL	-0.046768	-0.671408	0.502872
WASI_FullScale4compositescore	0.146573	2.112317	0.036120

$R^2 = 0.21$

$F(4,170) = 12.54$

$P = 0.000000$

Volume of subcortical gray matter at 20 years, WASI test (intellectual quotient) and duration of the kangaroo position



Rimol, L. M., Rise, H. H., Evensen, K. A. I., Yendiki, A., Løhaugen, G. C., Indredavik, M. S., ... & Skranes, J. (2023). Atypical brain structure mediates reduced IQ in young adults born preterm with very low birth weight. *Neuroimage*, 266, 119816.

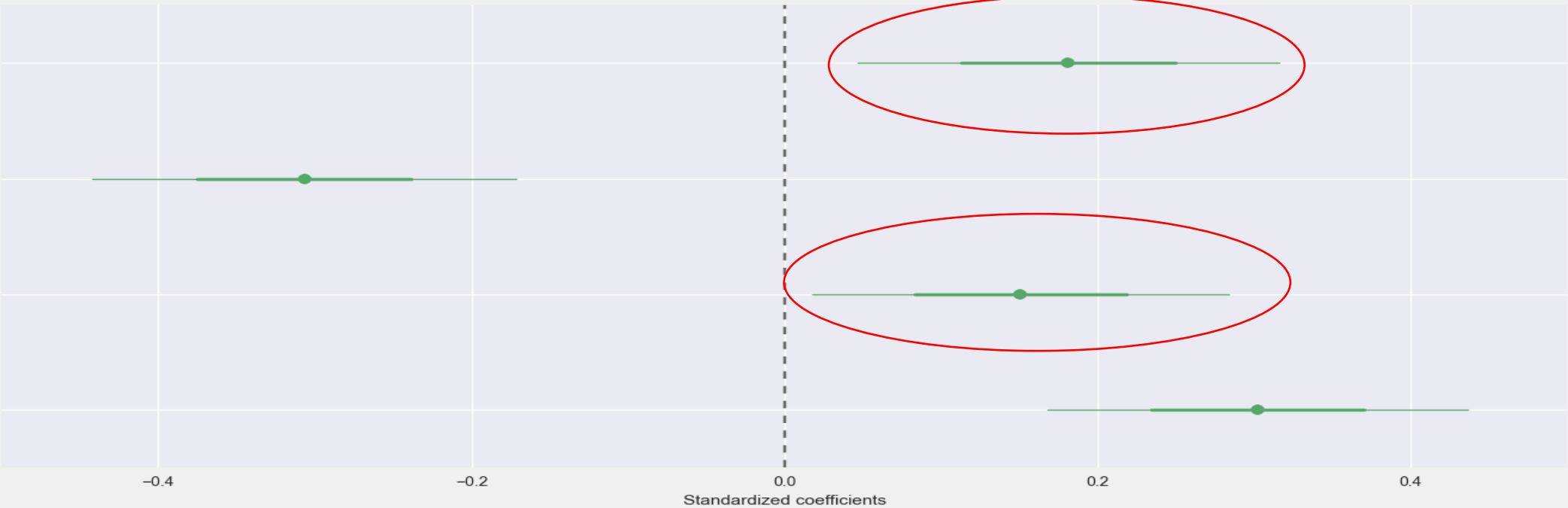
Volume du striatum, test de WASI (coefficient intellectuel) and duration of the KP at 20 years

WASI full scale

Severity index

KP duration (day)

Gender



Coefficients:

Coefficient	Slope	T Value	P Value
(Intercept)	-0.000000	-0.000000	1.000000
BIRTH_sex05	0.302529	4.448720	0.000016
EX41_durPCconcontrols03	0.150768	2.238095	0.026513
Fragility_Rasch_441_2PL	-0.306829	-4.476764	0.000014
WASI_FullScale4compositescore	0.181215	2.654151	0.008706

R² = 0.23

F(4,170) = 14.35

P = 0.000000

Brain volumes, KMC and fine motor skills of the premature or LBW infant



NHPT (Nine Hold Peg Test)

The Gold standard evaluation for fine motor skills and coordination

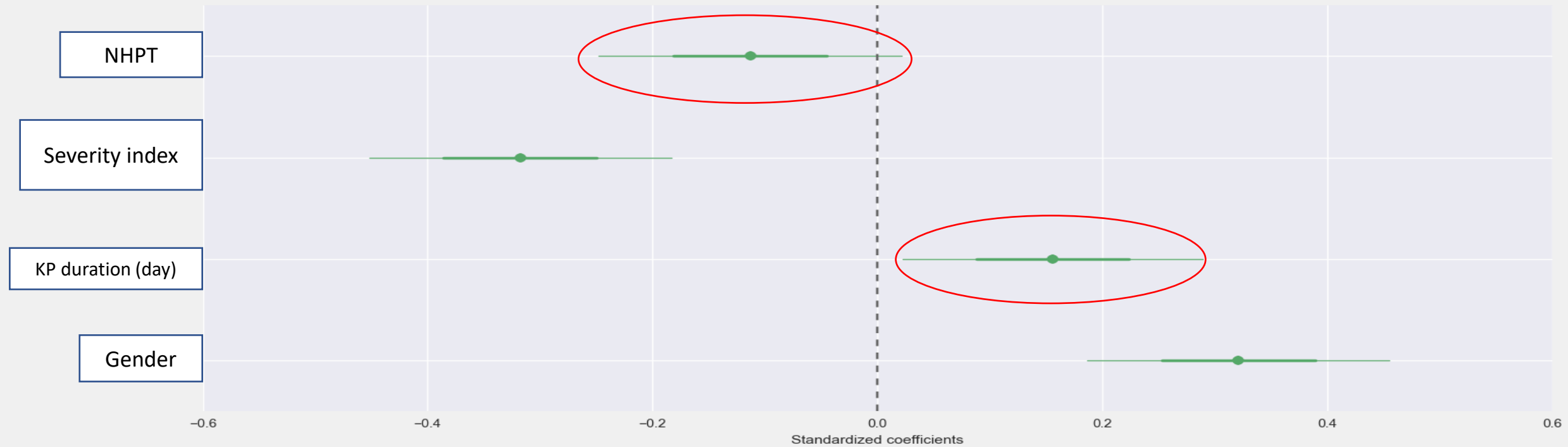
- Used in research and clinical practice
- Measures upper extremity dysfunction
- A combination of predominantly motor and sensory symptoms results in upper extremity disability, impairing the ability to perform activities of daily living and social activities, resulting in decreased quality of life.

Bolk, J., Padilla, N., Forsman, L., Broström, L., Hellgren, K., & Åden, U. (2018). Visual-motor integration and fine motor skills at 6½ years of age and associations with neonatal brain volumes in children born extremely preterm in Sweden: a population-based cohort study. *BMJ open*, 8(2), e020478.

Dathe, A. K., Jaekel, J., Franzel, J., Hoehn, T., Felderhoff-Mueser, U., & Huening, B. M. (2020). Visual perception, fine motor, and visual-motor skills in very preterm and term-born children before school entry—observational cohort study. *Children*, 7(12), 276.

Hintz, S. R., Barnes, P. D., Bulas, D., Slovis, T. L., Finer, N. N., Wrage, L. A., ... & SUPPORT Study Group of the Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. (2015). Neuroimaging and neurodevelopmental outcome in extremely preterm infants. *Pediatrics*, 135(1), e32-e42.

Striatum volume, NHPT and duration of the Kangaroo Position at age 20



Coefficients:

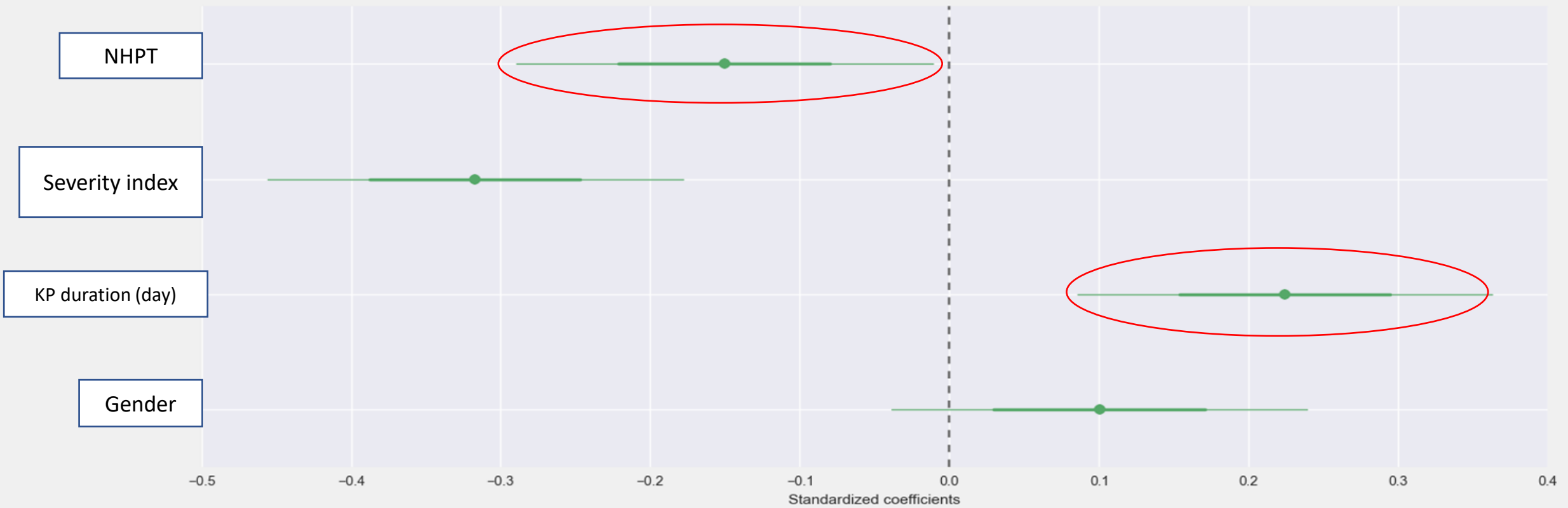
Coefficient	Slope	T Value	P Value
(Intercept)	0.000000	0.000000	1.000000
BIRTH_sex05	0.320918	4.714529	0.000005
EX41_durPCconcontrols03	0.155771	2.299650	0.022663
Fragility_Rasch_441_2PL	-0.317737	-4.670104	0.000006
NHPT_promedioMD	-0.113296	-1.660572	0.098611

$R^2 = 0.22$

$F(4,173) = 13.27$

$P = 0.000000$

Caudate nucleus volume, duration of kangaroo position and NHPT (fine motor skills) at age 20



Coefficients:

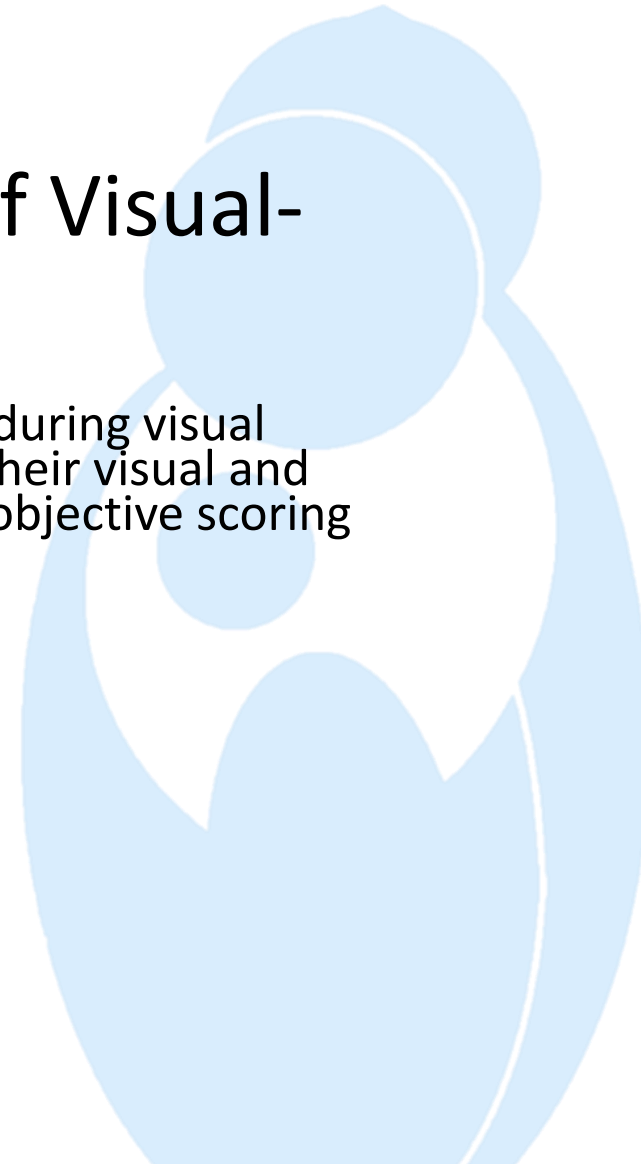
Coefficient	Slope	T Value	P Value
(Intercept)	-0.000000	-0.000000	1.000000
BIRTH_sex05	0.100294	1.423118	0.156503
EX41_durP...	0.224111	3.195669	0.001658
Fragility_Ra...	-0.317089	-4.501556	0.000012
NHPT_pro...	-0.150370	-2.128767	0.034689

(VMI) Beery-Buktenica Developmental Test of Visual-Motor Integration

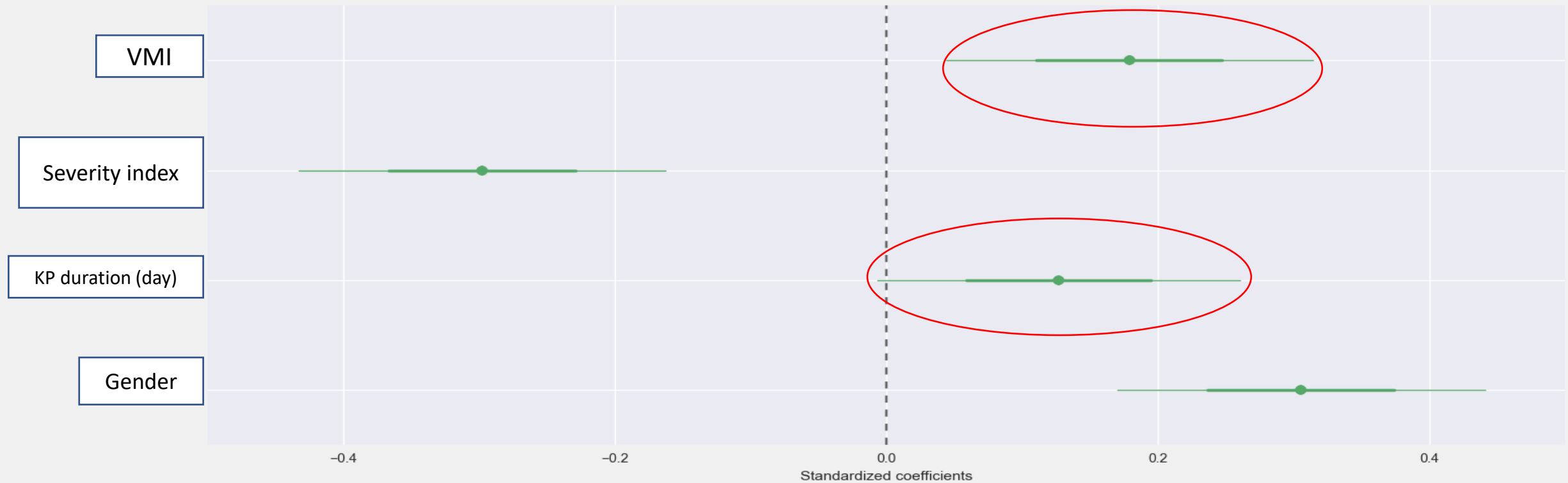
- -The Beery VMI (sixth edition) is a copy forms test that is frequently administered during visual perceptual evaluations. It measures the extent to which individuals can integrate their visual and motor abilities. It is a well-researched, commonly used, standardized test with an objective scoring system.

Produces 3 scores:

- *a) Visual perception*
- *b) Motor coordination*
- *c) Visuo-motor integration*



VMI and total subcortical gray matter volume



Coefficients:

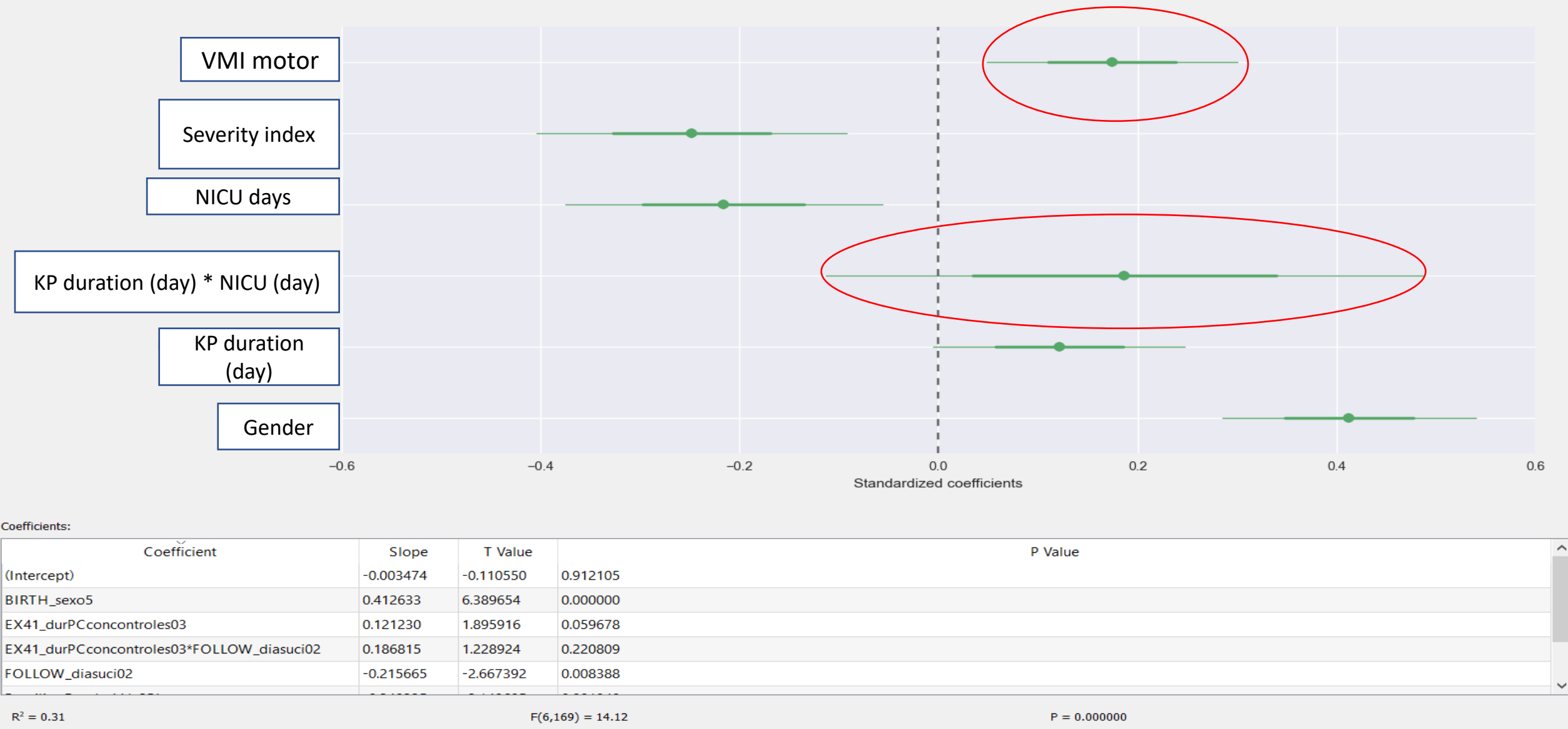
Coefficient	Slope	T Value	P Value
(Intercept)	0.000000	0.000000	1.000000
BIRTH_sex05	0.305455	4.449858	0.000016
EX41_durPCconcontroles03	0.127046	1.875081	0.062507
Fragility_Rasch_441_2PL	-0.297545	-4.339142	0.000025
VMI_estandar	0.179163	2.625209	0.009454

$R^2 = 0.22$

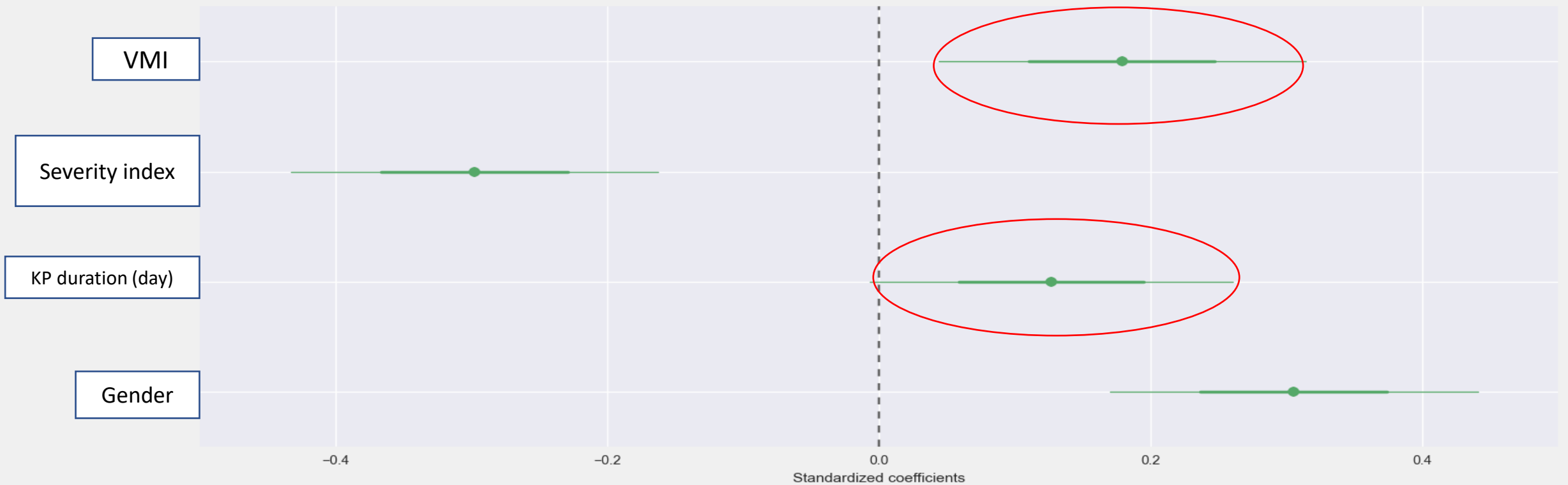
$F(4,169) = 13.46$

$P = 0.000000$

VMI motor, subcortical gray matter volume and days in NICU (proxy for stress)



VMI and striatum volume



Coefficients:

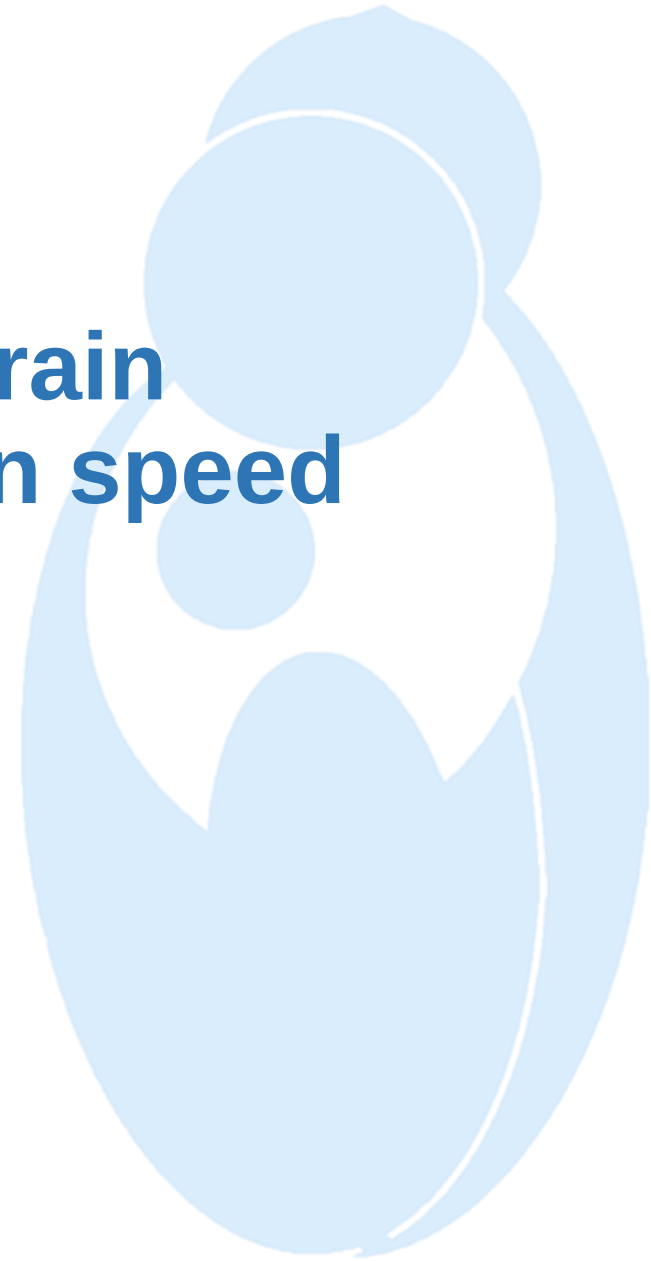
Coefficient	Slope	T Value	P Value
(Intercept)	0.000000	0.000000	1.000000
BIRTH_sex05	0.305455	4.449858	0.000016
EX41_durPCconcontrols03	0.127046	1.875081	0.062507
Fragility_Rasch_441_2PL	-0.297545	-4.339142	0.000025
VMI_estandar	0.179163	2.625209	0.009454

$R^2 = 0.22$

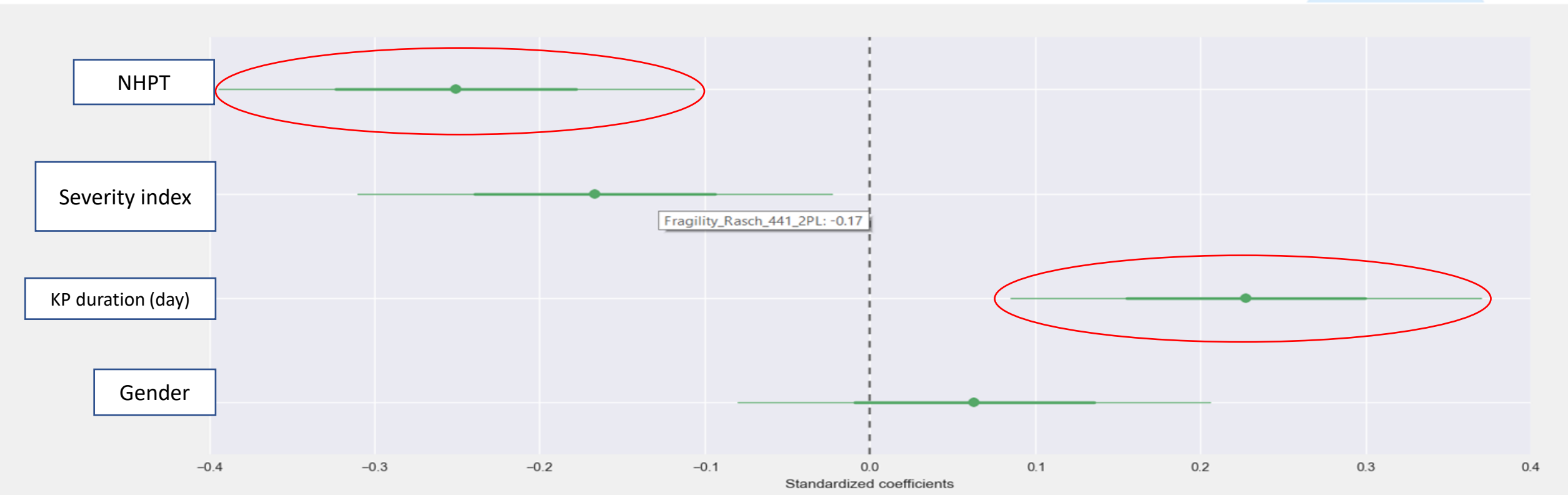
$F(4,169) = 13.46$

$P = 0.000000$

**White matter, fine motor skills, brain
organization, coordination, execution speed**



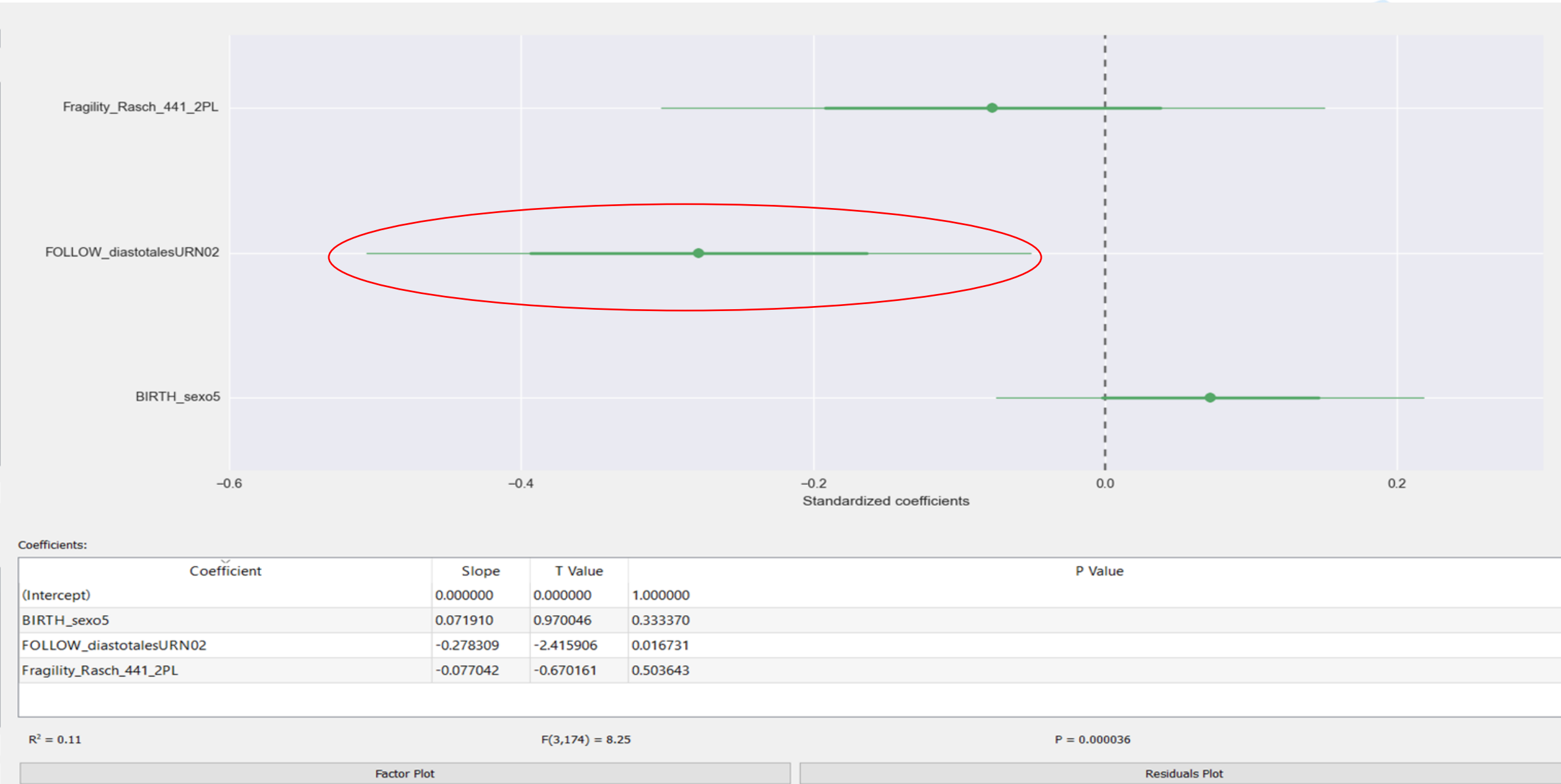
Anisotropy fraction (white matter organization) and NHPT (motor task execution speed)



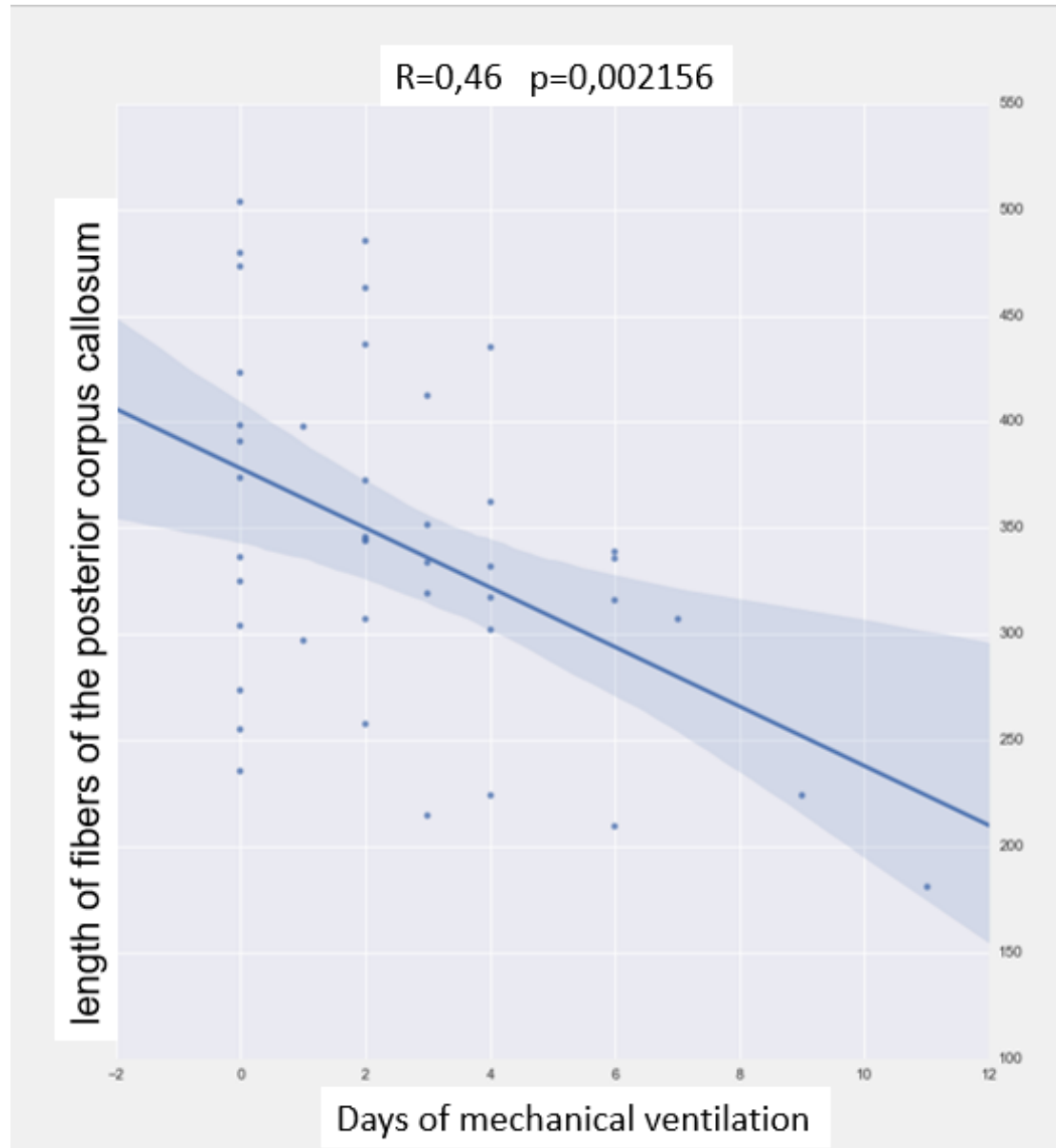
Coefficients:

Coefficient	Slope	T Value	P Value
(Intercept)	0.000000	0.000000	1.000000
BIRTH_sex05	0.062983	0.869467	0.385818
EX41_durP...	0.227738	3.154856	0.001899
Fragility_Ra...	-0.166394	-2.287834	0.023379
NHPT_pro...	-0.250592	-3.440171	0.000731

Posterior corpus callosum volume and length of neonatal hospitalization



Correlation between days of mechanical ventilation and posterior Corpus Callosum volume



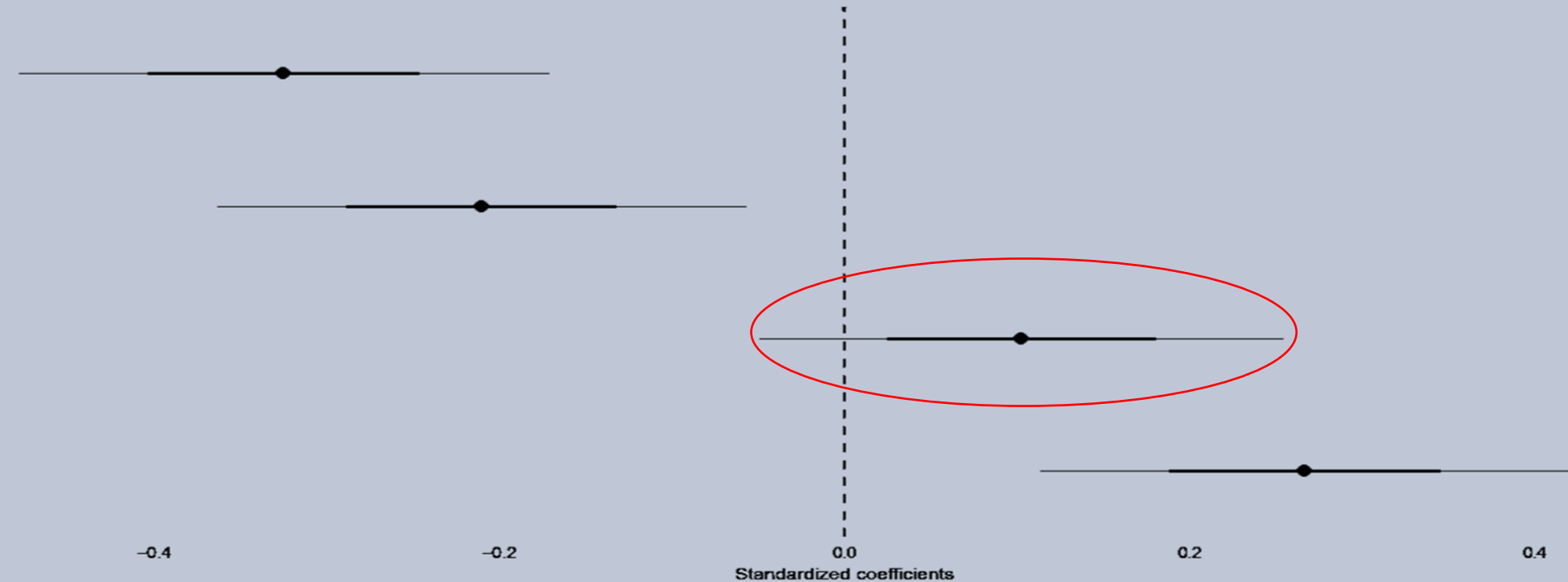
Corpus Callosum fiber length and fine motor skills (NHPT) in infants hospitalized during the neonatal period

NHPT
average

Severity-
rash-index

KP duration
(Days)

Gender



Coefficients:

Coefficient	Slope	T Value	P Value
Intercept		-0.000000	1.000000
Gender		3.444347	0.000768
KP duration (Days)		1.333371	0.184707
Severity		-2.720553	0.007396
NHPT average		-4.192635	0.000050

R² = 0.23

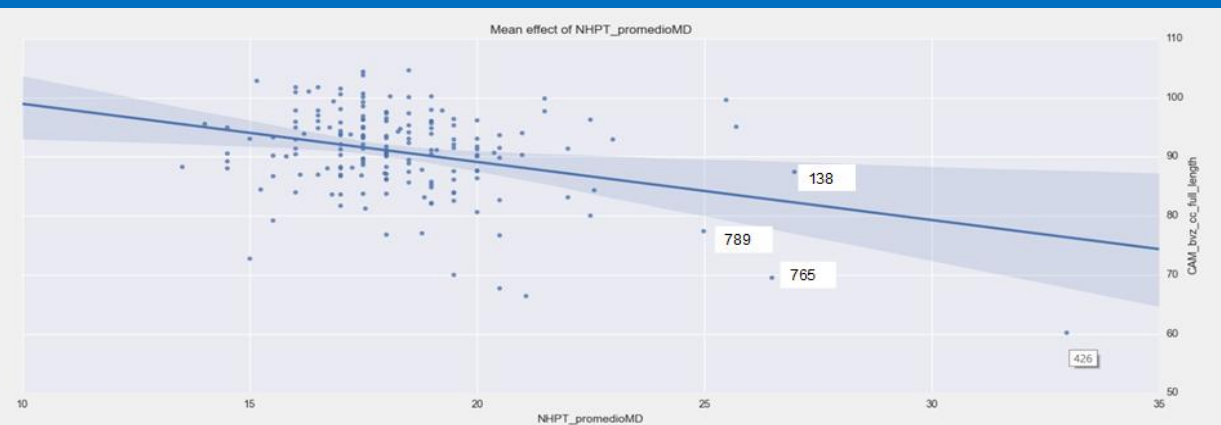
F(4,132) = 10.98

P = 0.000000

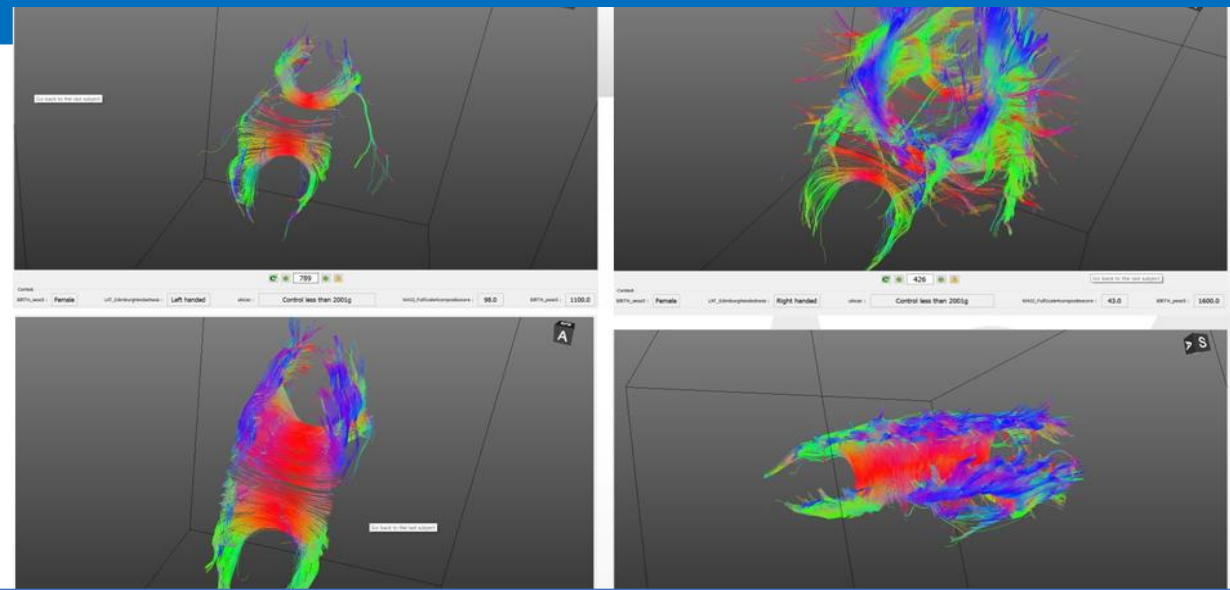
Factor Plot

Residuals Plot

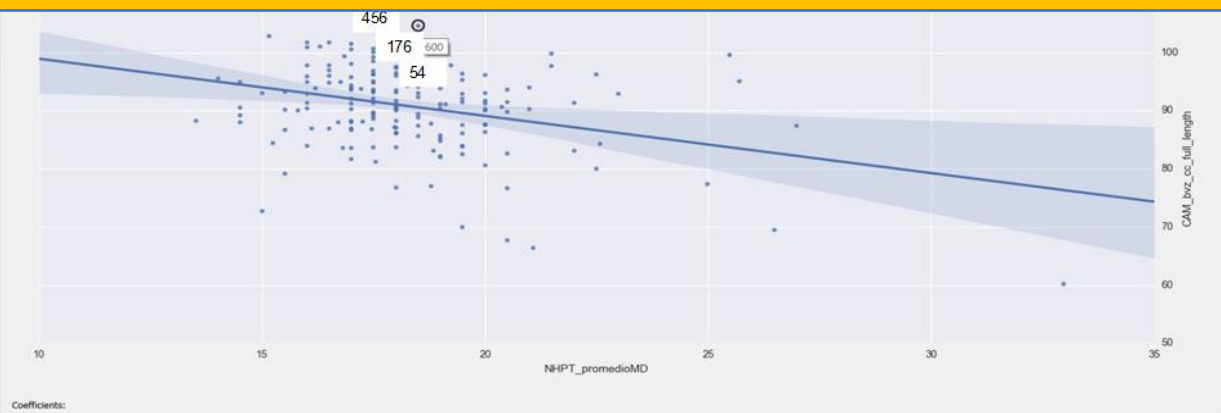
Results of the Exploratory Analysis



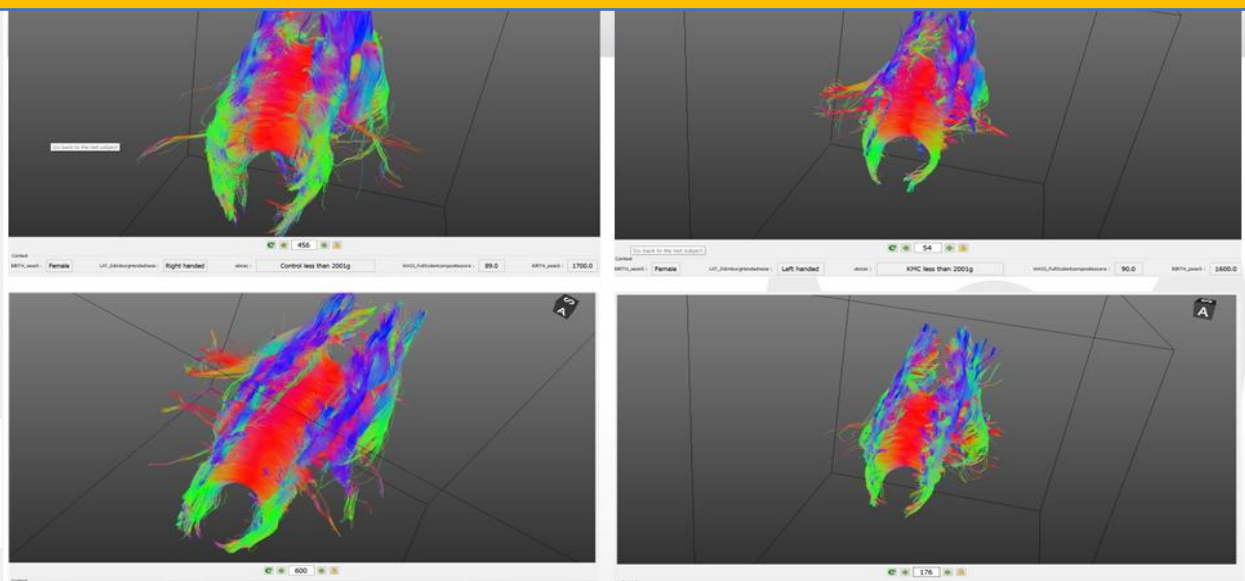
The 4 longest fine motor tests measured with the NHPT with the shortest fibers in the corpus callosum



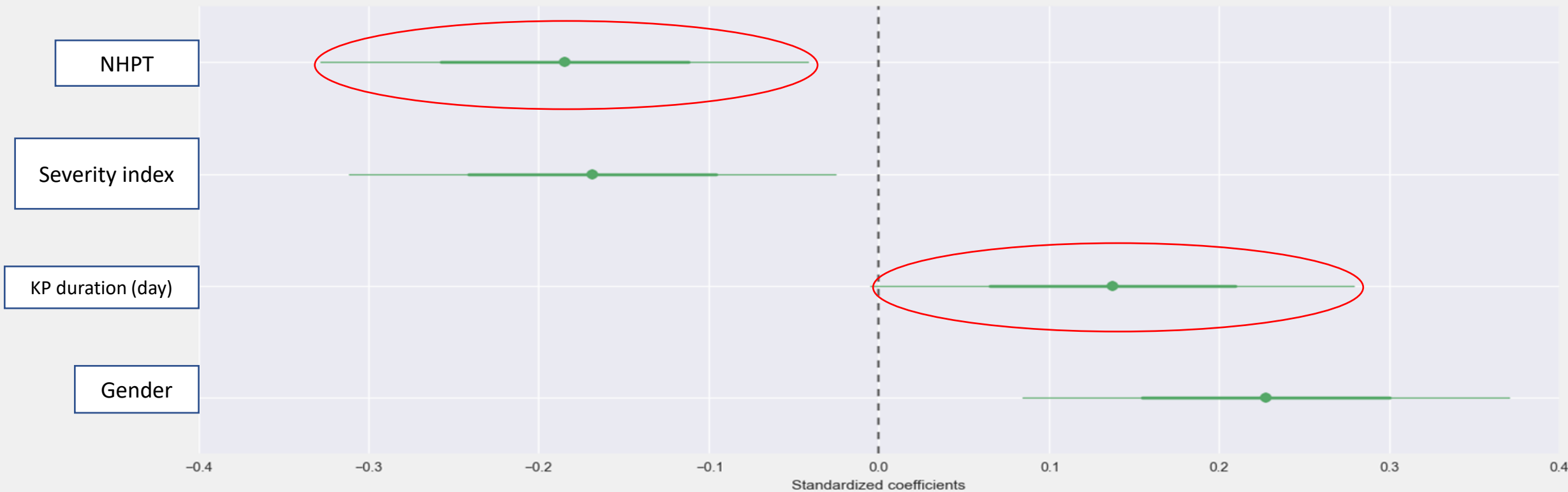
Visualization of the corpus callosum in the four best short tests and compared them visually with the four longest tests and indeed, there are clear visual anatomical differences.



The 4 shortest fine motor tests measured with the NHPT with the longest fibers in the corpus callosum



Cerebellum volume and NHPT (coordination) at age 20



Coefficients:

Coefficient	Slope	T Value	P Value
(Intercept)	-0.000000	-0.000000	1.000000
BIRTH_sex05	0.227554	3.140486	0.001984
EX41_durP...	0.137173	1.902444	0.058774
Fragility_Ra...	-0.168421	-2.325534	0.021204
NHPT_pro...	-0.184795	-2.544493	0.011818

R² = 0.11

F(4,173) = 6.63

P = 0.000054

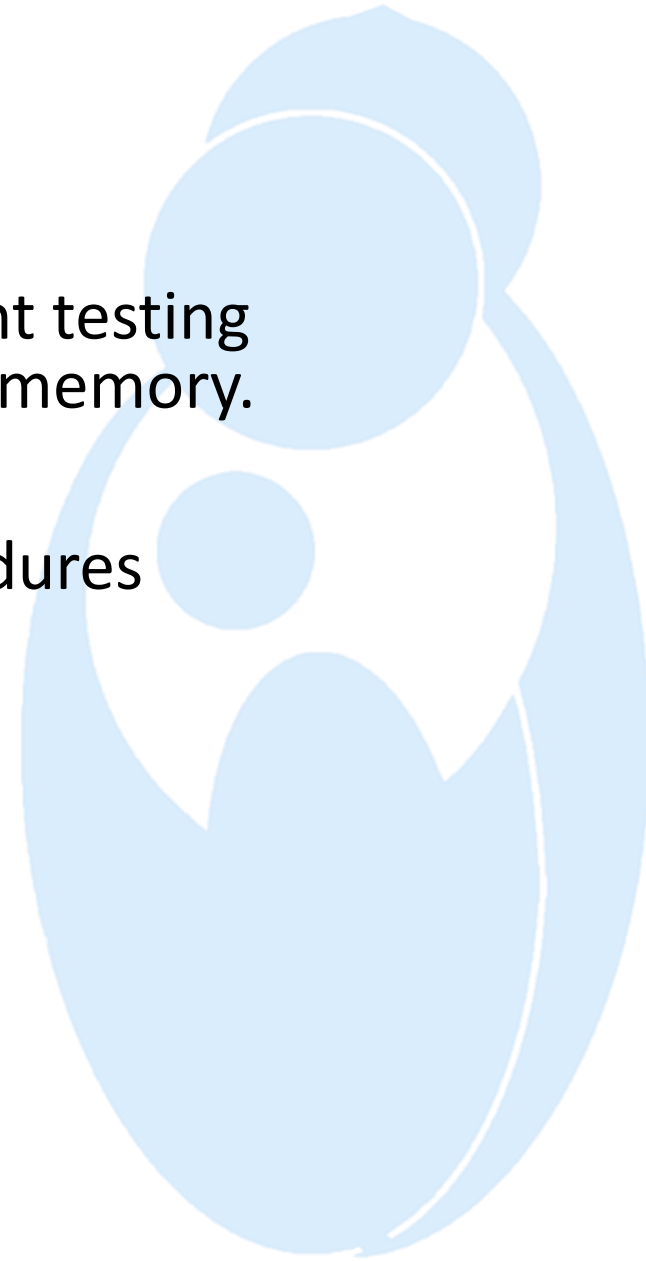
- Memory: California Verbal Learning Test (CVLT)

Requires to learn and remember lists of words under different testing conditions, including free recall, cued recall and recognition memory.

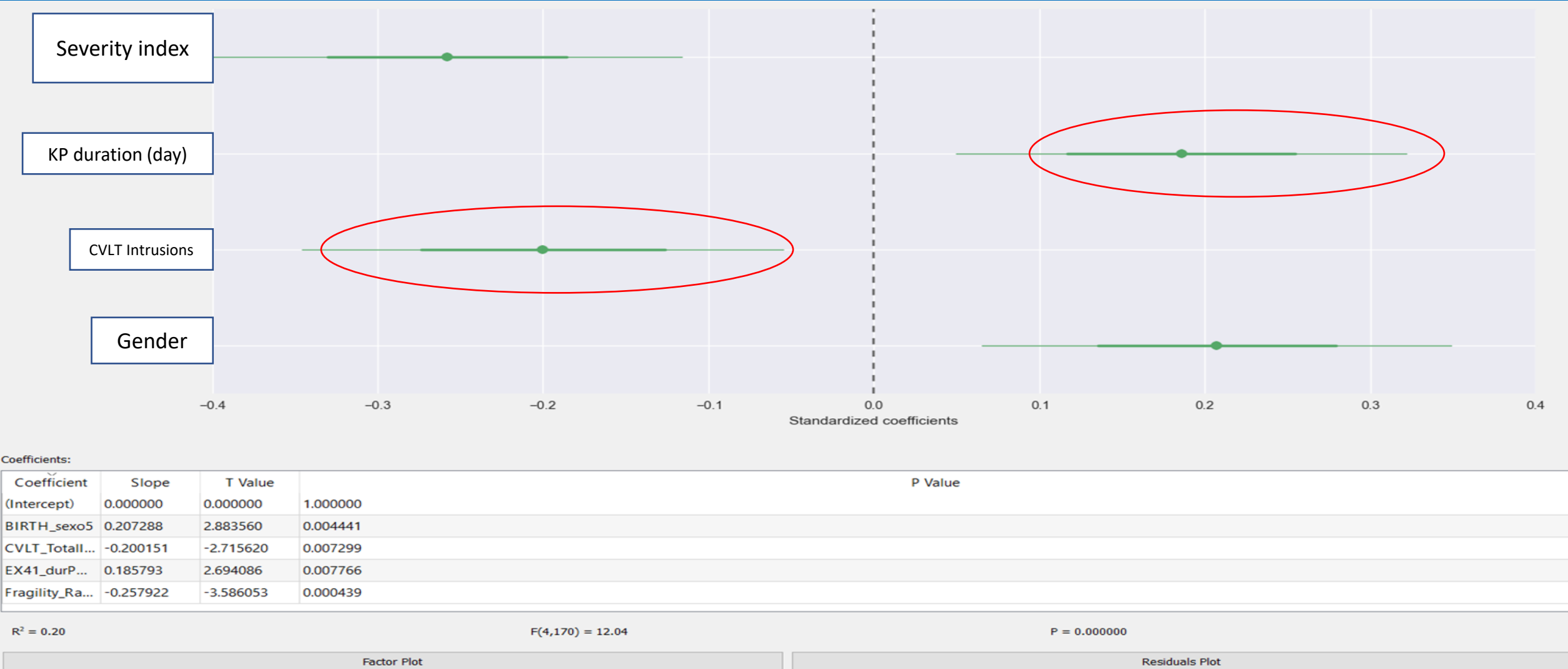
Produces 10 scores, which vary according to the recall procedures

Mainly:

- 1 fact score for short and long delay recall
- 1 fact score for intrusions
- 1 raw score for repetitions



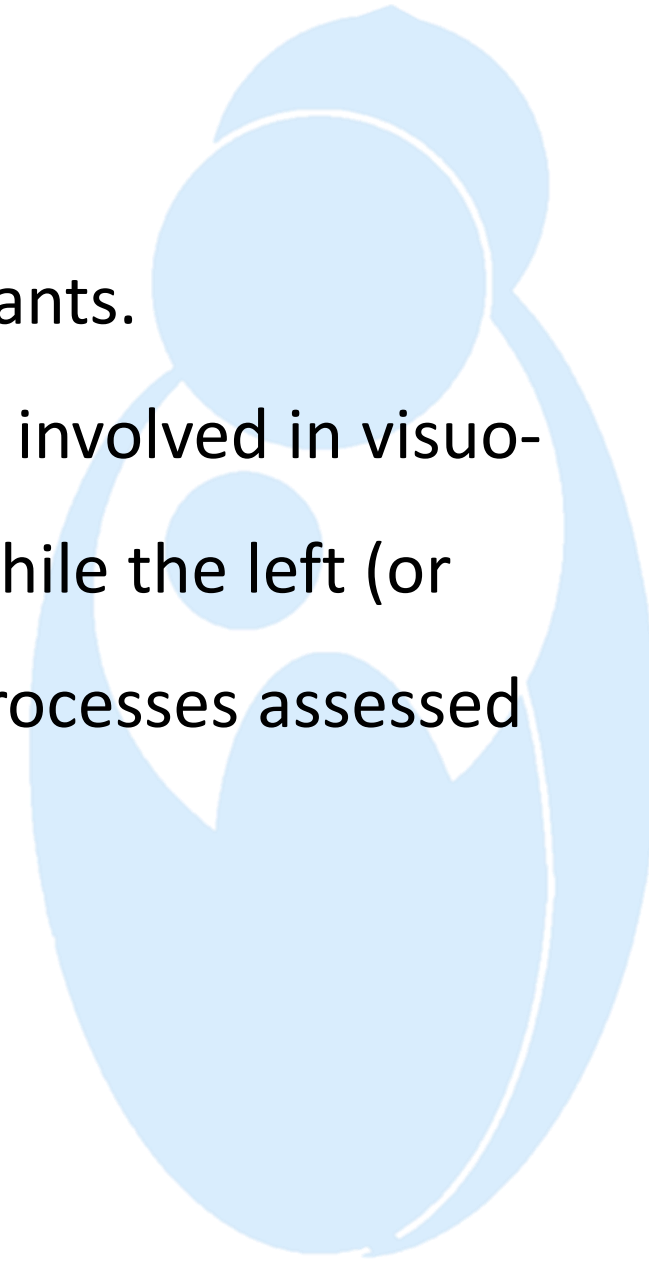
Striatum volume and CVLT test (memory) and duration of the Kangaroo Position at age 20



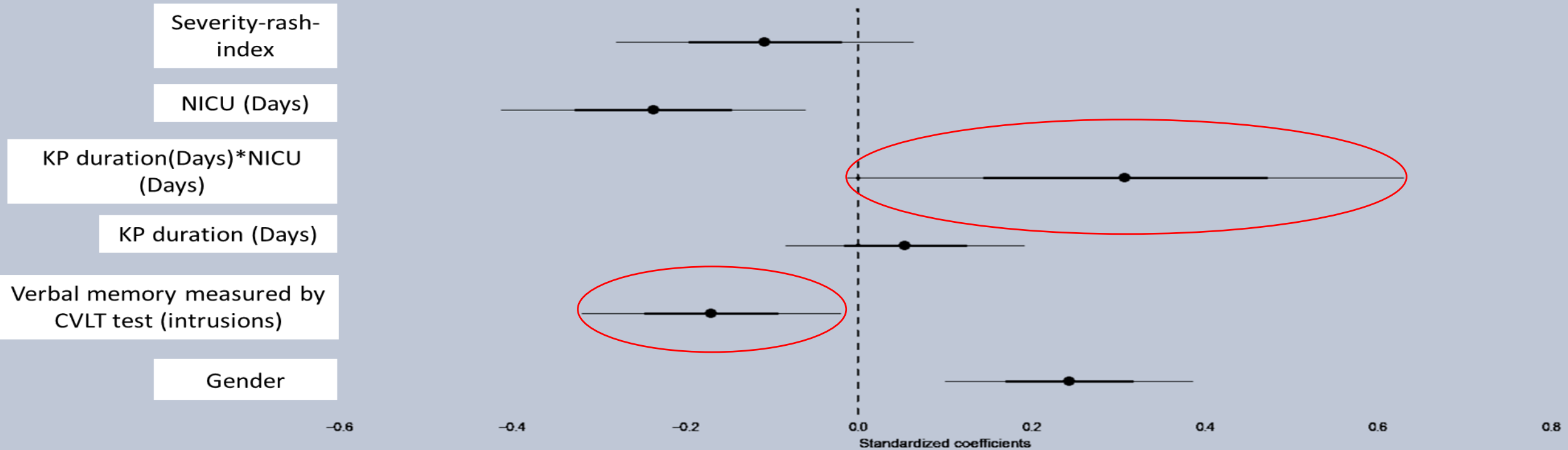
Rolando, F. (2022). *Striatal and hippocampal dynamics during time categorization* (Doctoral dissertation, Lyon 1).

Badreddine, N. (2020). *Caractérisation des substrats neuronaux de la mémoire procédurale: rôle de la dynamique des réseaux corticostriataux* (Doctoral dissertation, Université Grenoble Alpes).

- Particularly sensitive to hypoxia
- Smaller volume in preterm infants compared to term infants.
- The right (or non-dominant) hippocampus is particularly involved in visuo-spatial memory processes assessed with the VMI test, while the left (or dominant) hippocampus is involved in verbal memory processes assessed with the CVLT test.



Hippocampus volume and verbal memory (CVLT)



Coefficients:

	Coefficient	Slope	T Value	
(Intercept)		-0.005869	-0.172207	0.863482
Gender		0.242573	3.349989	0.000998
Verbal memory measured by CVLT test (intrusions)		-0.170788	-2.261098	0.025036
KP duration (Days)		0.053368	0.766561	0.444418
KP duration(Days)*NICU (Days)		0.307645	1.890106	0.060466

R² = 0.19

F(6,168) = 7.96

Control by fragility and gender
More days in NICU, less volume
Despite being in the NICU, more Kangaroo Position, more volume
Less intrusions more volume

Factor Plot

Residuals Plot

Hippocampus volume and visual memory (VMI)

Visual memory measured by
VMI test

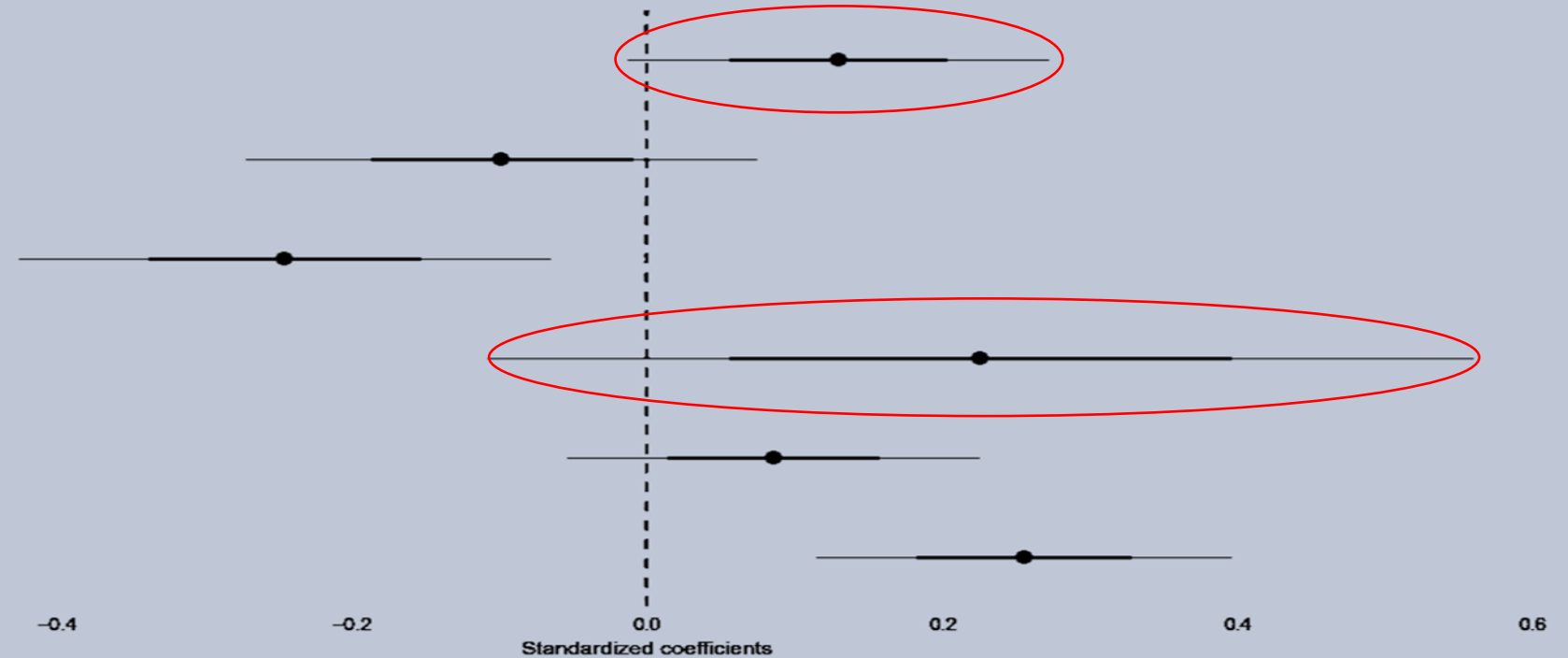
Severity-rash-
index

NICU (Days)

KP duration(Days)*NICU
(Days)

KP duration (Days)

Gender



Coefficients:

Coefficient	Slope	T Value	
KP duration (Days)	0.085360	1.208412	0.228597
KP duration(Days)*NICU (Days)	0.225302	1.333588	0.184155
NICU (Days)	-0.246141	-2.700928	0.007628
Severity-rash-index	-0.098818	-1.128649	0.260665
Visual memory measured by VMI test	0.129250	1.792113	0.074925

$R^2 = 0.17$

$F(6,167) = 6.72$

Control by fragility and gender
More days in NICU, less volume
Despite being in the NICU, more Kangaroo Position,
more volume
more volume, higher result in the VMI

Factor Plot

Residuals Plot

Brain volumes, Emotion control, social behaviour, KMC and prematurity

We correlated the parents report based on behaviours of the young adult and the volume of the brain amygdala

ASEBA (ABCL 113 items Likert 0-2) Achenbach System of Empirically Based Assessment

It gives standardized ratings and descriptive details of adults' social and mental functioning, as seen by the adults themselves and/or by others, in this case we used the parents report.

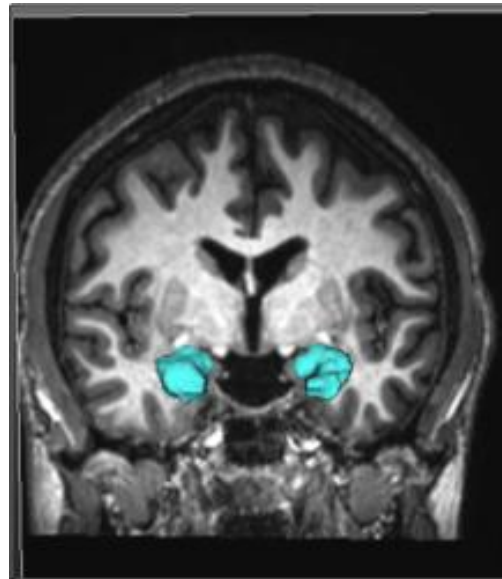
Gives 8 symptoms (*anxious/depressed, withdrawn, somatic complaints, thought problems, attention problems, aggressive problems, rule breaking and intrusive behaviors*)
... and *Internalized and Externalized and a Total score*

Moreover, it gives 5 *DSM based symptoms* and allows to define 3 clinical level: *Normal, Borderline and Clinical*

Brain amygdala and prematurity

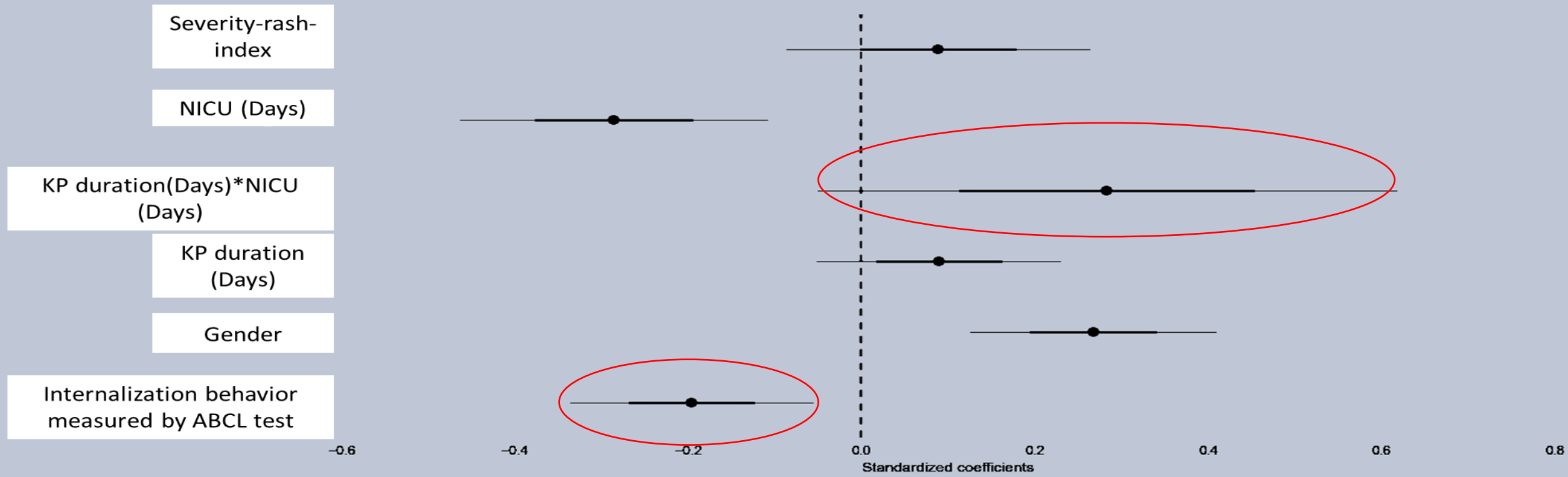
- The brain amygdala play an important role in social development and neural control of emotions, especially fear and emotions.
- These structures are particularly vulnerable to injury and stress in premature birth.

Schmitz-Koep, B., Zimmermann, J., Menegaux, A., Nuttall, R., Bäuml, J. G., Schneider, S. C., ... & Sorg, C. (2021). Decreased amygdala volume in adults after premature birth. *Scientific Reports*, 11(1), 5403.



Mueller, M. E., Graz, M. B., Truttmann, A. C., Schneider, J., & Duerden, E. G. (2024). Neonatal amygdala volumes, procedural pain and the association with social-emotional development in children born very preterm. *Brain Structure and Function*, 1-10.

Brain amygdala volume and internalization (ABCL/parents)



Coefficients:

Coefficient	Slope	T Value	
Internalization behavior measured by ABCL test	-0.196220	-2.772034	0.006192
Gender	0.266930	3.727716	0.000263
KP duration (Days)	0.088835	1.249980	0.213025
KP duration(Days)*NICU (Days)	0.282923	1.674400	0.095891
NICU (Days)	-0.285971	-3.179560	0.001753

R² = 0.14

F(6,170) = 5.75

Volume of amygdala

Control by fragility and gender

More days in NICU, less volume

Despite being in the NICU, more Kangaroo Position, more volume

Less internalization, more volume

Brain amygdala volume and externalisation (ABCL/parents)

Severity-rash-index

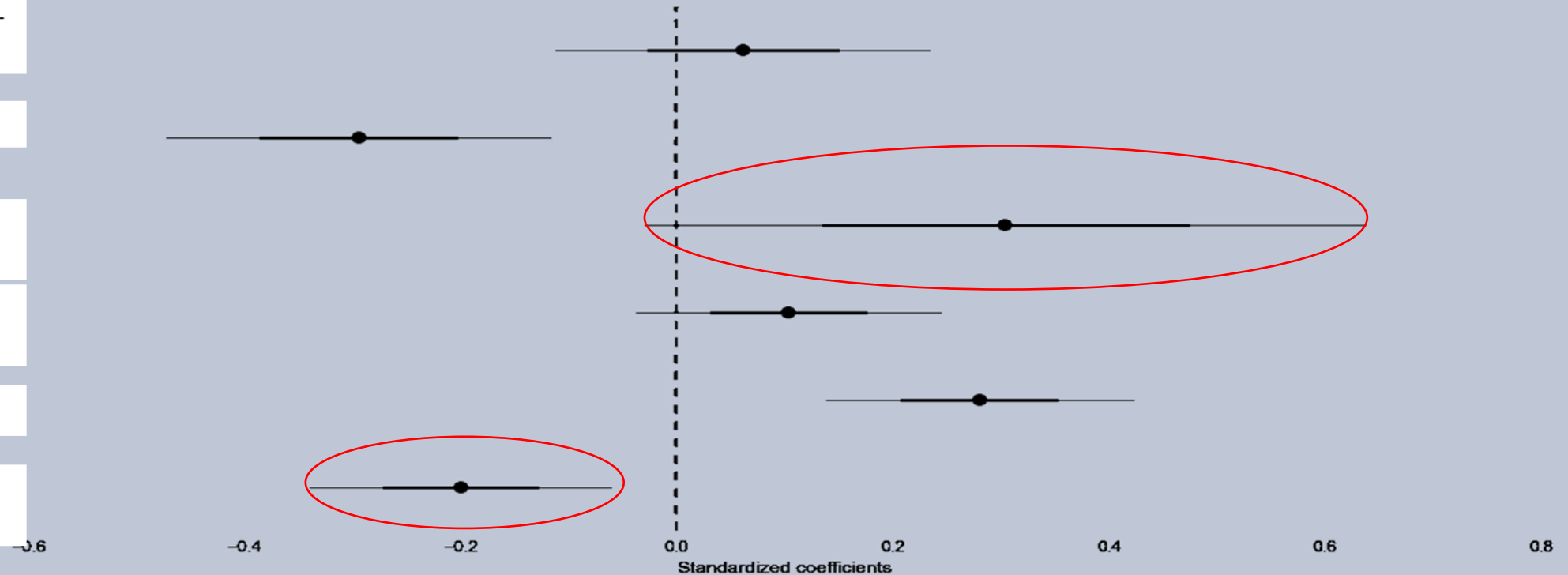
NICU (Days)

KP duration(Days)*NICU (Days)

KP duration (Days)

Gender

Externalization behavior measured by ABCL test



Coefficients:

Coefficient	Slope	T Value	
Externalization behavior measured by ABCL test	-0.200213	-2.838840	0.005080
Gender	0.280075	3.897752	0.000139
KP duration (Days)	0.103129	1.449081	0.149157
KP duration(Days)*NICU (Days)	0.303970	1.801329	0.073423
NICU (Days)	-0.294644	-3.276157	0.001276

R² = 0.14

F(6,170) = 5.82

Control by fragility and gender
More days in NICU, less volume
Despite being in the NICU, more Kangaroo
Position, more volume
Less externalization, more volume

Factor Plot

Residuals Plot



Brain Amygdala Volume and Internalization/Externalization (ABCL/Parents)

- Volume of the cerebral amygdalae, once controlled by fragility and gender is correlates with the days in NICU (more days in NICU, less volume), with the interaction between kangaroo position and days in NCIU (despite being in the NICU, more kangaroo position, more volume) and the score of internalization/externalization is in relation with the volume of brain amygdalae.



Hippocampus Volume and Verbal Memory (CVLT) or visual memory (VMI)

- The hippocampus is also an organ that is extremely sensitive to asphyxia and prematurity.
- Controlling by fragility and gender
- We found that more days in NICU, less hippocampus volume.
- Despite being in the NICU, more kangaroo position, more volume, and less intrusions (CVLT) or increase score of the VMI when more volume of the hippocampus.



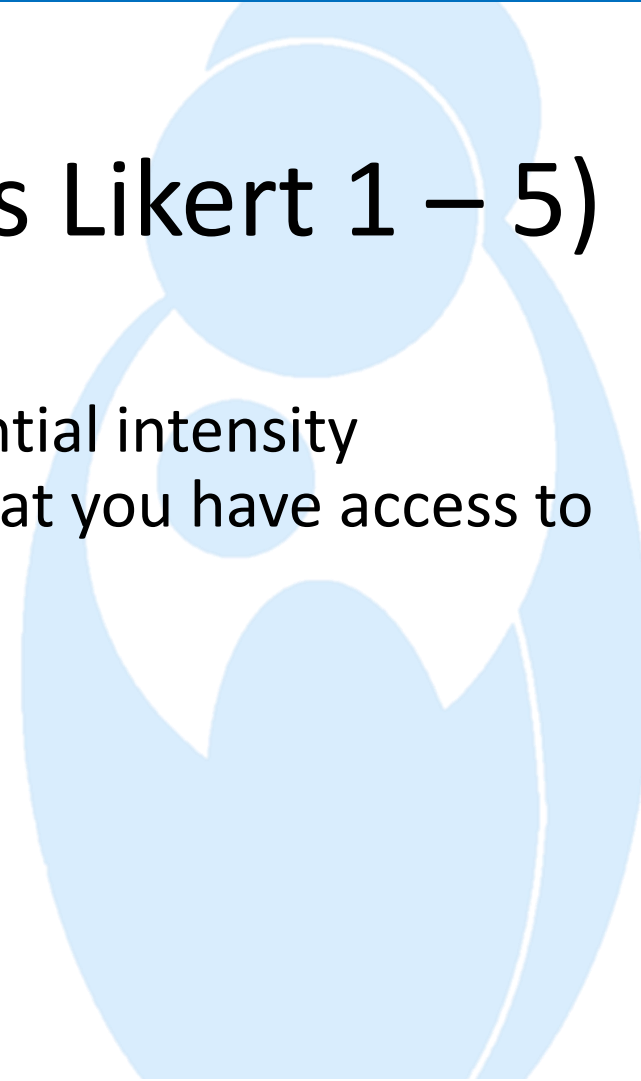
These findings provide new insight into the critical period of ex-utero preterm brain development and the effect that KMC could have on brain protection and plasticity in promoting functional connectivity and synaptic efficacy.



Attachment with the mother and prematurity

Attachment relationship: IPPA (25 items Likert 1 – 5)

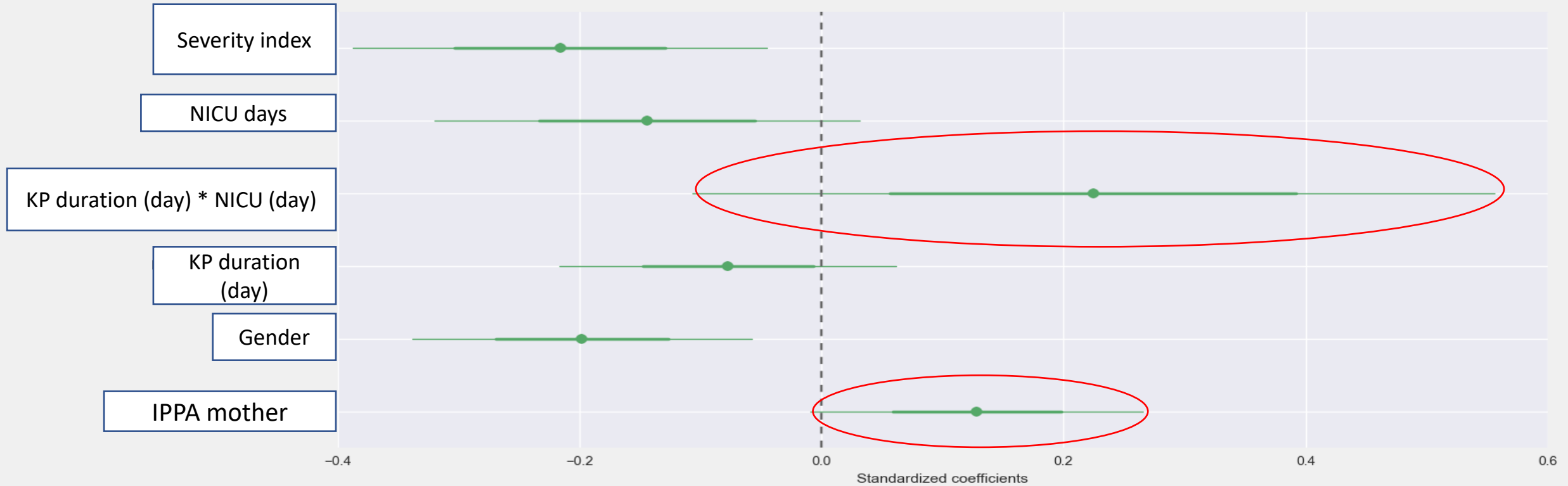
- Inventory of Parents and Peers Attachment
- Attachment is defined as an enduring affection bond of substantial intensity between the family members and self. It gives the assurance that you have access to trustworthy, and helpful others.



KMC and Attachment

		KMC N=222	Control N=197	Reference N=49	P Kruskal-Wallis
Total Attachment Score (IPPA). Median		64	61	56	0.04
Quality of Attachment N (%)	Secure	99(45)	66(33)	14(29)	0.02
	Ambivalent	78(35)	94(48)	20(41)	
	Avoidant	45(20)	37(19)	15(30)	

IPPA, stress (NICU), duration of the KP and acumbens nucleus volume



Coefficients:

Coefficient	Slope	T Value	P Value
(Intercept)	-0.004025	-0.116079	0.907727
APEGO_Attachment_apego_total	0.128264	1.845114	0.066761
BIRTH_sex05	-0.197846	-2.791439	0.005848
EX41_durPCconcontrols03	-0.077226	-1.096692	0.274327
EX41_durPCconcontrols03*FOLLOW_diasuci02	0.224309	1.336886	0.183046

$R^2 = 0.16$

$F(6,170) = 6.39$

$P = 0.000004$

Neuro-physiology and neuro-images at 20 years waiting for in-deep analysis

- Stimulation magnétique transcrânienne (TMS) (400)
- Imagerie par résonance magnétique (IRM) (200)
- IRM fonctionnelle, avec 5 paradigmes : coordination(200), préhension motrice (200), attention(100), mémoire (100), Peur/émotion(100)
- Tractographie (DTI) (200)

We are looking for in-deep analysis of our 20-year-old material, and I'm hopeful that new results will help us to better understand prematurity and the impact of KMC on the immature brain, and help us to definitively convince our colleagues around the world that it's no longer ethical not to integrate KMC as a routine part of neonatal care, as early as possible and for as long as possible, until we reach the zero separation standard of care requested by the WHO.

The only possible conclusion is that what we are doing during this period after birth with these fragile infants may have very long-term and definitive repercussions.



Special Issue Article

KMC and Brain Development: A Plea for Starting KMC as Early as Possible and as Long as Possible

Nathalie Charpak^{1,2}, Catalina Lince-Rivera^{1,3}, and Jose Tiberio Hernandez¹

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Summary: KMC and Neurodevelopment

From brain protection at birth to cognitive gains lasting 20 years

Brain Structure

Higher gray & white matter volumes measured by MRI at age 20

Cognitive Function

Higher IQ, better memory, attention & executive function

Motor Development

Better fine motor skills linked to corpus callosum fibers

Behavior & Emotion

Reduced hyperactivity, aggression & internalization disorders

Prematurity & the Developing Brain: A Critical Vulnerability

The 24–40 Week Critical Window

Brain volume grows ×1.5 during this period

Cortex surface area multiplies ×4 (sulci & convolutions)

Premature birth interrupts this process — the infant's brain must now develop ex-utero, exposed to a very different and often stressful environment.

Neurodevelopmental Risks of Prematurity

5–10% — severe deficits (cerebral palsy, cognitive delay, sensory impairment)

25–50% — milder but impactful: coordination, executive function, language, learning

40–60% — LBW children need specialized educational support

KMC as a Neuroprotective Response

Just as pulmonary surfactant supports immature lungs, KMC acts as a "brain surfactant" — providing the sensory, biological, and emotional environment the preterm brain urgently needs during its most critical developmental window.

6 Simultaneous Channels of Stimulation

Vestibular Movements of maternal thorax

Tactile Skin-to-skin contact & warmth

Olfactory Body & breast milk scent

Auditory Voice, breathing & heartbeat

Visual Eye contact during KP & feeding

Proprioceptive Contained position in Lycra band

KMC and Brain Structure: MRI Evidence at 20 Years (Charpak et al., Acta Paediatrica 2022)

RCT cohort re-enrolled at age 20 (n=264, ≤1800g at birth) · MRI processed with FreeSurfer, SPM, Camino · Controlled for fragility index & gender

Gray Matter

- ↑ Total gray matter volume
- ↑ Cortical gray matter volume
- ↑ Striatum, caudate & putamen nuclei
- ↑ Cerebellar volume
- Dose-dependent: each additional day in KP → more volume

White Matter

- Significantly better organization (↑ Fractional Anisotropy)
- ↑ Length of corpus callosum fibers
- Corpus callosum connects the two hemispheres — thinner in prematurity
- Days of mechanical ventilation negatively correlated with fiber length
- KMC duration positively correlated with fiber length

Subcortical Structures

- Amygdala: preserved volume → better emotional regulation
- Hippocampus: preserved volume → stronger verbal & visual memory
- Both structures sensitive to prematurity-related hypoxia
- KP days offset NICU hospitalization damage
- Effect maintained even in infants with long NICU stays

"The kangaroo position acts as a neuroprotective agent — its sustained use shows dose-dependent effects on total gray matter, cortex, basal ganglia, and cerebellum."
— Charpak et al., 2024

KMC and Cognitive, Behavioral & Motor Outcomes Across the Lifespan

12 months

Higher Bayley MDI & PDI scores in KMC vs. traditional care (Tessier et al. 2003)

8–15 years

Better cognitive control, IQ & brain circuit efficiency; benefits persist into adolescence (Feldman 2014; Schneider et al.)

20 years

IQ advantage in most fragile group (+0.5 SD); reduced hyperactivity, aggression & antisocial conduct (Charpak et al., Pediatrics 2017)

Cognitive & Memory Outcomes

Cognition: Increments in standardized cognitive scores associated with KP duration

Memory: Better verbal memory (CVLT) & visual memory (VMI) linked to larger hippocampus volume

Attention: Reduced attention deficits; KMC parents provide more stimulating home environment

Motor & Behavioral Outcomes

Fine motor: Corpus callosum fiber length correlated with KP days → better Nine-Hole Peg Test

Behavior: ↓ Hyperactivity, aggressiveness, internalization & externalization disorders

Social: KMC families show less separation; fathers more present & nurturing at 20 years

A Dose-Dependent Effect: Every Day in Kangaroo Position Counts

Mathematical models show statistically significant increases in brain structure volumes per each additional day in KP, controlling for perinatal illness severity and gender.

Total Gray Matter ↑ volume per KP day	Cortical Gray Matter ↑ volume per KP day	Caudate Nucleus ↑ → higher IQ & social behavior	Cerebellum ↑ volume per KP day
Amygdala Preserved from NICU damage by KP	Hippocampus ↑ volume → better memory	Corpus Callosum ↑ fiber length → fine motor skills	White Matter (FA) ↑ organization → faster signaling

Clinical implication: It is no longer ethical not to apply KMC. Every hour of separation from the kangaroo position is a missed neuroprotective opportunity.

Frontier Research: Inter-Brain Synchrony & the Neurodevelopment of iKMC (2025–2026)

Hyperscanning Research (2026)

Technology: Dual fNIRS hyperscanning records simultaneous brain activity in mother and infant

Finding: The first KMC session immediately enhances inter-brain synchrony between mother and infant

Significance: This "neural tuning" is linked to better organization of the infant's own brain networks — KMC's neuroprotective effect starts with the very first skin-to-skin contact

iKMC Neurodevelopment Follow-Up (Ongoing)

The WHO Immediate KMC Study Group (2023) has launched a multi-country follow-up protocol to assess the neurodevelopmental impact of iKMC vs. stabilization-first KMC at 12–24 months using Bayley IV scales — results expected 2026–2027.

Systematic Review Evidence (2025)

Shah & Ayub, Journal of Neonatal Surgery 2025

Systematic review of studies 2010–2025 on KMC and neurodevelopment found:

Cognitive KMC positively influences cognitive trajectories, especially when started in the first week of life

Motor Early & prolonged KMC linked to better cognition, language & adaptive behavior at 12 months CA

Emotional Emotional regulation, mother–infant bonding & attentional responsiveness all improved with KMC exposure

Duration Benefits are sustained with prolonged KMC; short-duration KMC provides less neurological protection

Key gap: More long-term longitudinal data needed on caregiver consistency, socio-cultural factors, and health system integration in diverse settings.





KMC 5 ***** in a NICU



KMC 2025–2026: Key Messages

1 Zero Separation from Birth

Immediate KMC — even before stabilization — reduces mortality by 25%. WHO 2022 guidelines make this the global standard.

2 A Neuroprotective Investment

Every additional day in the Kangaroo Position builds brain structure. KMC produces measurable gains in gray matter, white matter & cognition lasting to age 20.

3 A Family-Centered Approach

Parents are primary caregivers, not visitors. KMC reduces postpartum depression by 24% and father involvement generates lasting benefits throughout childhood.

4 Proven at Scale in Colombia

57,154 infants over 28 years confirm steady improvements in growth, morbidity, and breastfeeding — with equity for the most vulnerable populations.

—

Remember:

it is unethical
not to use KMC as a
health professional.

—



Special Issue Article

KMC and Brain Development: A Plea for Starting KMC as Early as Possible and as Long as Possible

Nathalie Charpak^{1,2} , Catalina Lince-Rivera^{1,3}  and Jose Tiberio Hernandez¹ 

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SMALL
BRAINS
BIG
POTENTIAL



Our vision

We have a very promising project to evaluate the neurological development of these vulnerable children, but unfortunately, we did not find the funds to carry it out.



Proposed study

We aim to conduct a randomized study comparing 4 neuromotor tests and predictors of cerebral palsy, applied at 3 months of corrected age: **Amiel-Tison** triad, **Hammersmith** test, **INFANIB** test and **General Movements**, with follow-up until 2 years of corrected age to determine which screening best predicts cerebral palsy.

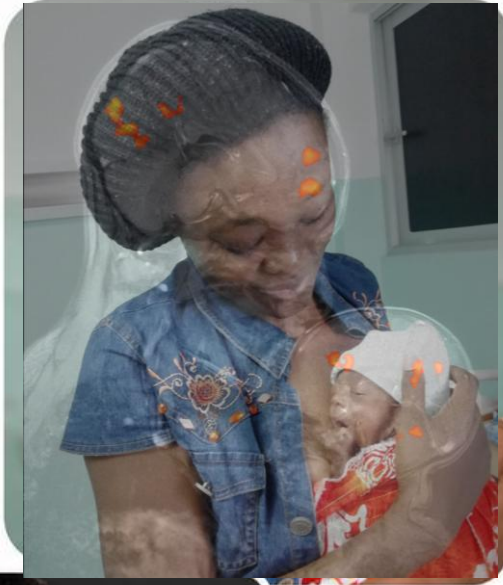
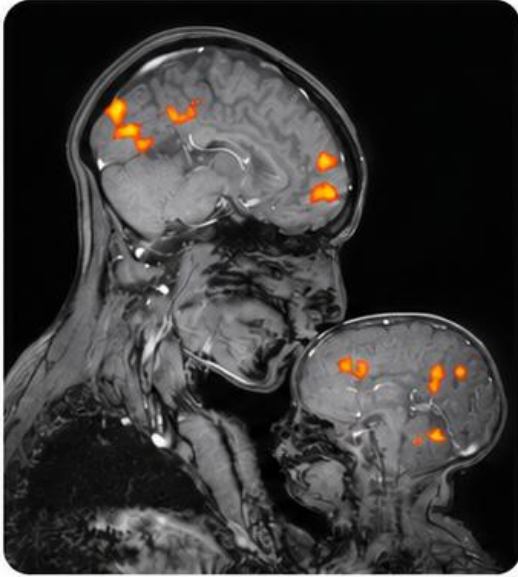


Resources needed

The estimated cost is high (**200,000 euros** for 2 years). The tests would be applied to a cohort of **433 children under 32 weeks**, included in two large KMC ambulatory programs in **Bogotá and Medellín**.

Attention

SMALL BRAINS · BIG FUTURES



J. Sizun, B.
Westrup,
Arch Dis Child
Fetal Neonat Ed
2004



Fragile brains in development...
...Let's protect them !



Memory of the 2024 Virtual International Meeting on KMC, with free access to all meeting videos on the INK website: www.kangaroomothercare.org.



INK

International Network in Kangaroo Mother Care

ABOUT US ▾

MEMORY OF EVENTS

KMC VIRTUAL CONGRESS 2024 ▾

REGISTER NOW

INTERNATIONAL KMC VIRTUAL CONFERENCE 2024:

The 30th birthday of the
Kangaroo Foundation

◀ Congress schedule: Every day from 7:00 a.m. to 11:00 a.m. (COT)

Registration fee: USD 50



**November 18 to 21
2024**



INK

International Network in Kangaroo Mother Care



15th International Kangaroo Care Conference, organized by the Brazilian Ministry of Health.
November 18–21, 2026, in Brasília. www.kangaroomothercare.org

SAVE
THE
DATE



Organização:



Apoio:



Preterm and/or LBW infants should not only survive, but survive with quality of life.



Muṭumesc

References (1/2)

Primary Research Articles

- [1] Charpak, N., Lince-Rivera, C., & Hernandez, J. T. (2024). KMC and brain development: A plea for starting KMC as early as possible and as long as possible. *Journal of Neonatology*. Advance online publication. <https://doi.org/10.1177/09732179241235479>
- [2] Charpak, N., & Montealegre-Pomar, A. (2023). Follow-up of Kangaroo Mother Care programmes in the last 28 years: Results from a cohort of 57,154 low-birth-weight infants in Colombia. *BMJ Global Health*, 8, e011192. <https://doi.org/10.1136/bmjgh-2022-011192>
- [3] Chi, L. K., Van Quyen, C., Montealegre-Pomar, A., & Charpak, N. (2026). Immediate Kangaroo Mother Care in a cohort of low-birth-weight infants (less than 1800g) in Vietnam. *Acta Paediatrica*. Advance online publication. <https://doi.org/10.1111/apa.70444>
- [4] Charpak, N., Montealegre-Pomar, A., Rosero, L. T., Lince-Rivera, C., & Cortés, D. (2024). Perinatal risk factors in ex-preterm/LBW Colombian young adults: Auditory and visual impairments. *The Lancet Regional Health – Americas*, 39, 100921. <https://doi.org/10.1016/j.lana.2024.100921>

20-Year Follow-Up & Longitudinal Studies

- [5] Charpak, N., Tessier, R., Ruiz, J. G., Hernandez, J. T., Uriza, F., Villegas, J., Nadeau, L., Mercier, C., Maheu, F., Marin, J., Cortes, D., Gallego, J. M., & Maldonado, D. (2017). Twenty-year follow-up of Kangaroo Mother Care versus traditional care. *Pediatrics*, 139(1), e20162063. <https://doi.org/10.1542/peds.2016-2063>
- [6] Charpak, N., Tessier, R., Ruiz, J. G., Hernandez, J. T., Uriza, F., Angulo, D., & Lince-Rivera, C. (2022). Kangaroo mother care had a protective effect on the volume of brain structures in young adults born preterm. *Acta Paediatrica*, 111(5), 1004–1014. <https://doi.org/10.1111/apa.16265>
- [7] Ropars, S., Tessier, R., Charpak, N., & Uriza, L. F. (2018). Long-term effects of Kangaroo Mother Care on cognitive functioning: Results from a longitudinal study. *Developmental Neuropsychology*, 43(1), 82–91. <https://doi.org/10.1080/87565641.2017.1422507>

WHO Guidelines & Clinical Efficacy

- [8] WHO Immediate KMC Study Group. (2021). Immediate Kangaroo Mother Care and survival of infants with low birth weight. *New England Journal of Medicine*, 384(21), 2028–2038. <https://doi.org/10.1056/NEJMoa2026486>
- [9] World Health Organization. (2022). WHO recommendations for care of the preterm or low-birth-weight infant. WHO. <https://www.who.int/publications/i/item/9789240058262>
- [10] Sazawal, S., & Dhingra, U. (2023). Kangaroo mother care for preterm or low birth weight infants: A systematic review and meta-analysis. *BMJ Global Health*. <https://doi.org/10.1136/bmjgh-2022-009728>

References (2/2)

Neurodevelopment & Cognitive Outcomes

- [11] Tessier, R., Cristo, M., Velez, S., Giron, M., de Calume, Z. F., Ruiz-Palaez, J. G., Charpak, Y., & Charpak, N. (1998). Kangaroo mother care and the bonding hypothesis. *Pediatrics*, 102(2), e17. <https://doi.org/10.1542/peds.102.2.e17>
- [12] Tessier, R., Cristo, M. B., Velez, S., Giron, M., Nadeau, L., Figueroa de Calume, Z., Ruiz-Palaez, J. G., & Charpak, N. (2003). Kangaroo Mother Care: A method for protecting high-risk low-birth-weight and premature infants against developmental delay. *Infant Behavior and Development*, 26(3), 384–397. [https://doi.org/10.1016/S0163-6383\(03\)00037-7](https://doi.org/10.1016/S0163-6383(03)00037-7)
- [13] Feldman, R., Rosenthal, Z., & Eidelman, A. I. (2014). Maternal-preterm skin-to-skin contact enhances child physiologic organization and cognitive control across the first 10 years of life. *Biological Psychiatry*, 75(1), 56–64. <https://doi.org/10.1016/j.biopsych.2013.08.012>
- [14] Shah, S. N. H., & Ayub, M. U. A. (2025). Neurodevelopmental outcomes in preterm infants receiving Kangaroo Mother Care: A systematic review. *Journal of Neonatal Surgery*, 14(32s), 7390–7401.

Prematurity & Brain Vulnerability

- [15] Inder, T. E., Volpe, J. J., & Anderson, P. J. (2023). Defining the neurological consequences of preterm birth. *New England Journal of Medicine*, 389(5), 441–453. <https://doi.org/10.1056/NEJMr2303347>
- [16] Adejuyigbe, E. A., Agyeman, I., Anand, P., et al. (2023). Evaluation of the impact of continuous Kangaroo Mother Care (KMC) initiated immediately after birth compared to KMC initiated after stabilization in newborns with birth weight 1.0 to <1.8 kg on neurodevelopmental outcomes: Protocol for a follow-up study. *Trials*, 24(1), 265. <https://doi.org/10.1186/s13063-023-07192-5>

Inter-Brain Synchrony & Frontier Research (2026)

- [17] Recent Advances in Kangaroo Mother Care (2023–2026). (2026). [Unpublished synthesis document]. Kangaroo Foundation, Bogotá, Colombia.
- Liu, Y., Xu, J., Wang, T., Shi, Z., Chen, X., Kong, Y., & Bei, F. (2026). The immediate effect of kangaroo mother care on Mother-infant inter-brain synchrony and infant brain function. *arXiv preprint arXiv:2603.16501*.