Changing Tomorrow's Health, *Today*

Taking the Next Step: Moving from Science to Policy

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The *Growing up in Singapore Towards healthy Outcomes (GUSTO)* Study

"GUSTO should now be regarded as the flagship for *all* pregnancy and birth cohorts across the world. It is a unique resource."

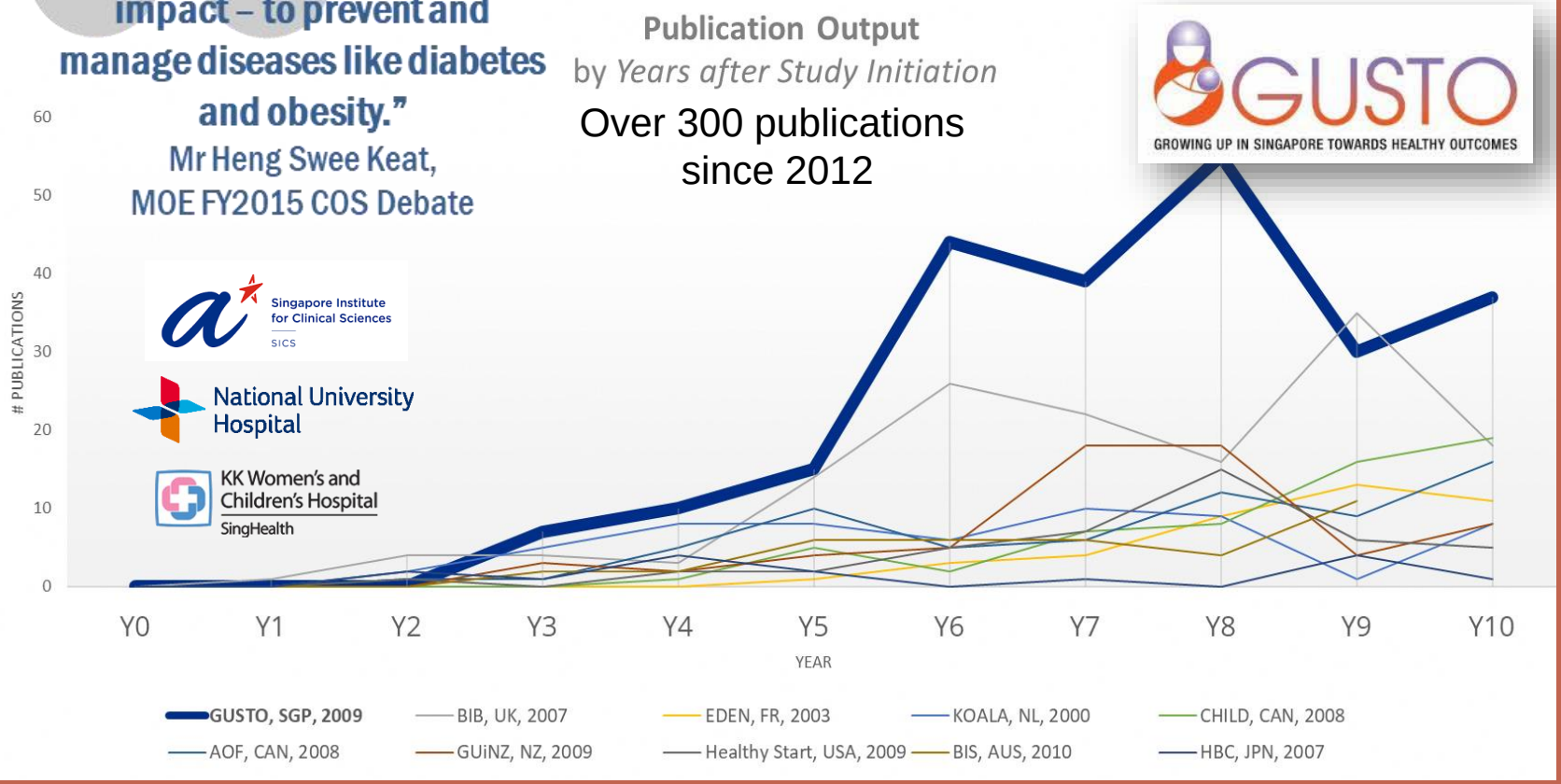
Professor The Lord Robert Winston, 2016

- 1247 mothers recruited in 2009
- Over 1000 mums and children still on follow-up
- From early pregnancy through to Age 12 today
- Wide & deep longitudinal phenotyping that is unprecedented

"A study with great national impact – to prevent and manage diseases like diabetes and obesity."
Mr Heng Swee Keat,
MOE FY2015 COS Debate

Publication Output
by *Years after Study Initiation*

Over 300 publications since 2012

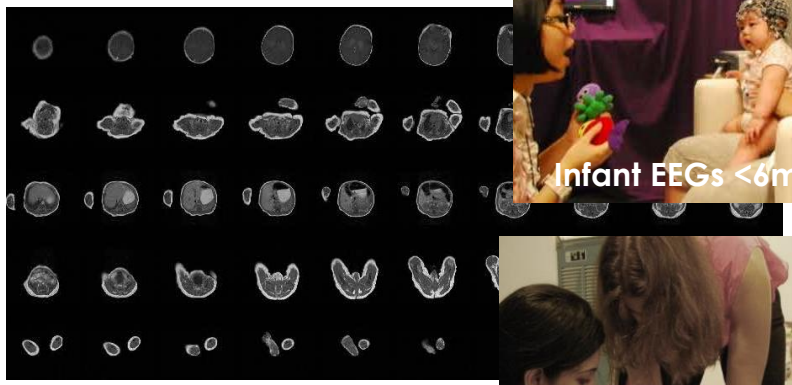


GUSTO: Detailed Measures and Observations from Birth to Today

Pushing new boundaries for measuring body & brain activity from birth


EEG on Day 1 of life


MRI



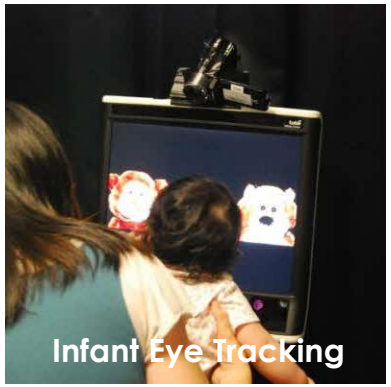
MRI repeated at 4.5, 6, 8, and 10 years of age

Detailed follow-up through infancy and early childhood


Infant EEGs <6mths


Parent-Child Interactions

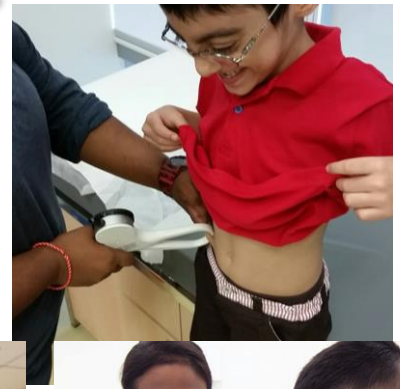

Anthropometry


Infant Eye Tracking

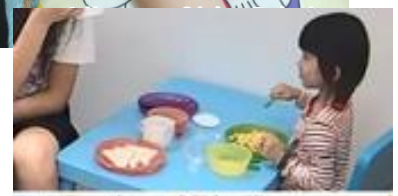
Continuing into annual assessments through middle childhood


Body Comp via Quantitative MR

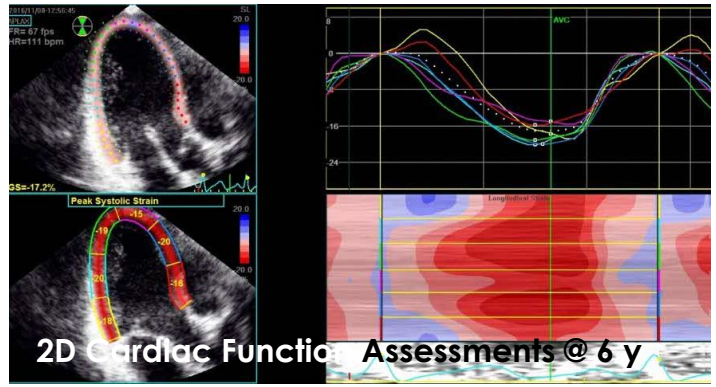

Body Comp via BodPod




Learning Assessments




Food Choice & Eating



2D Cardiac Functio Assessments @ 6 y

The GUSTO Study

GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Since its inception in 2009, the GUSTO study has received significant support, and in return, birthed new initiatives that include:

RESEARCH FUNDING SUPPORT

45 competitive grants

RIE2025 assured funding through Human Health & Potential

IMPROVING PRACTICE & POLICY

2009 - 2010 | Enabling non-sedating protocols for safer, infant MRIs

2014 – 2023 | Prioritizing antenatal mental health of mums-to-be

2017 -2018 | Improving care for gestational diabetes

2022 | 24h physical activity guidelines for young children

2022 – 2023 | Calibrating screen time recommendations for young children

SEEDING THE NEXT-GEN *of* RESEARCH PROFESSIONALS

8 Masters

21 PhDs

7 post-graduate candidates

348 peer-reviewed publications

CREATING NOVEL SCIENTIFIC KNOWLEDGE

15 patents filed

Human Health & Potential (HHP)

An individual is conceived with a set of **intrinsic health and abilities** that **develop along trajectories** that are influenced by **biological**, **environmental** and **socioeconomic** factors throughout their life course.

Aim

To help individuals get the **best start to life** and to **develop optimally** throughout their **life course**.

Preconception | Prenatal | Childhood | Adolescence | Adulthood | Elderly

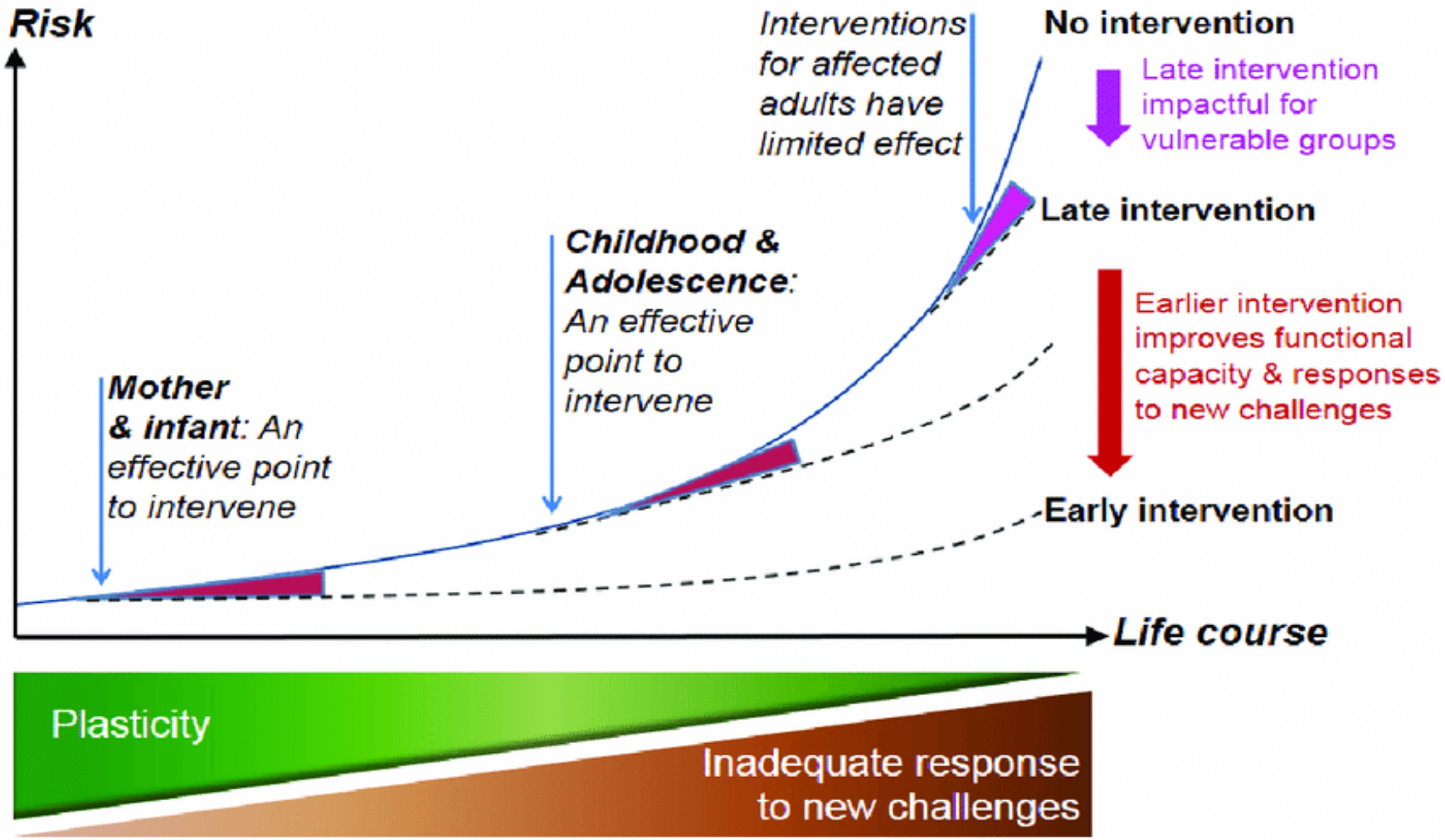
Early Life Physical, Neurocognitive & Emotional Development

Healthy Longevity

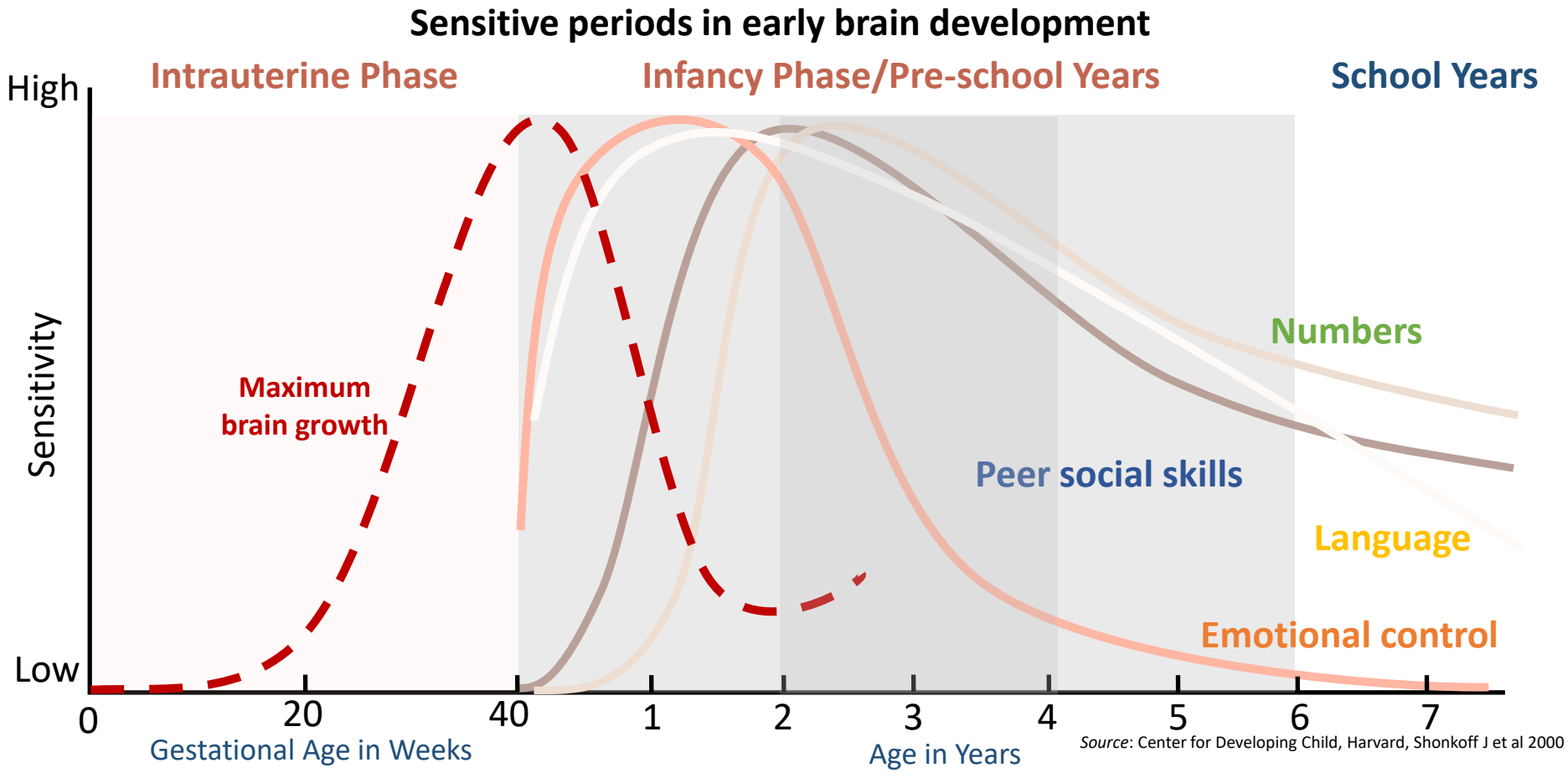
Overlapping transitions

Function & Performance

KEY PRINCIPLE:
Early intervention to enhance HHP



Interventions should happen when the brain is malleable



The ***Antenatal*** and ***Pre-school*** **periods** are **critical windows of opportunity**

In particular, the **ages between 2 – 4 years** offer an excellent opportunity to **identify *and* intervene** at a period poised between developmental stability and plasticity

"…we have to explore new possibilities for developing our people fully."

DPM Heng Swee Keat on adapting to change in a post-COVID-19 world, delivered during the debate on the President's Address in Parliament on 31 August 2020

"Studies in Singapore by Prof Chong Yap Seng show that the physical and mental health of women during pregnancy affects the brain development and behaviours of their babies…

The National Research Foundation is expanding on this by supporting research programmes that address the broader goal of **enhancing human potential**…"

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Govts must drive inclusive, sustainable growth: Wong

They need to relook approach to tackling challenges, says minister in US speech

Sue-Ann Tan
Business Correspondent

Faced with uncertain economic prospects, a rich-poor divide and climate change, governments must relook their approach to drive inclusive and sustainable growth, said Finance Minister Lawrence Wong yesterday.

This means repurposing fiscal policy and the role of the state towards building longer-term capacity and public goods, which can include infrastructure, healthcare and education.

Mr Wong was speaking at the Peterson Institute for International Economics, an independent research organisation, as part of a trip to the United States.

He was also making his first public speech since he was announced as the leader of the ruling People's Action Party's fourth-generation team last week, a move that paves the way for him to be Singapore's next prime minister.

"Economies everywhere have still not fully recovered from the lingering effects of Covid-19, especially in restoring supply chains," he said. "We now face another major challenge, precipitated by the war in Ukraine. We are not out of the frying pan, but already into another fire."

These issues add to the structural challenges of growth, inclusion and sustainability, he added.

Globalisation is heading into a new era of decoupling, with the possibility of a more divided world economically that mirrors a more divided world politically, he added.

Growth has also been less inclusive, Mr Wong pointed out, as technology has contributed to the shrinking of middle-class jobs in some industries and Covid-19 also hit unskilled workers disproportionately.

Meanwhile, the need for meaningful action on climate change grows greater, especially as reliance on fossil fuels is expected to increase in the short term with the Ukraine conflict.

"This may be necessary to cope with the short-term energy shortages, and to keep the lights on. But it also means we must redouble our efforts in the medium and longer term, to set the right price for carbon, regulate emissions and invest in cleaner, low-carbon technologies," he said.

NATIONS MUST WORK TOGETHER

Today, the world seems more divided than ever before. The future has never seemed more uncertain. But amidst our differences, we must find enough common ground with one another to solve our collective problems... Failure to cooperate internationally, preserve stability and invest in the global commons will have disastrous long-term consequences for the entire world.

FINANCE MINISTER LAWRENCE WONG

To respond to these challenges, Mr Wong noted that it "is not just about the amount of spending, but how and what we spend on".

Public spending can work better for the common good, through spending on rejuvenating and expanding critical infrastructure, investing in early child development and renewing areas that experienced economic decline, he suggested.

Tackling these issues would also require wider and deeper collaborations between the public and private sectors. In R&D, for instance, both sides could work together to drive technological breakthroughs in areas of pressing need, such as green solutions to tackle climate change, even when the technologies are not yet bankable or investable.

Globally, Mr Wong also suggested strengthening multilateral cooperation on global public goods, which includes supporting countries in building up their national healthcare capacities to tackle new health threats.

International cooperation can also help tackle climate change, he said, which involves creating global standards for disclosures and reporting.

Ultimately, the international system has to be kept open and inclusive, with multilateralism fortified, Mr Wong said.

"Today, the world seems more divided than ever before. The future has never seemed more uncertain. But amidst our differences, we must find enough common ground with one another to solve our collective problems."

He warned: "Failure to cooperate internationally, preserve stability and invest in the global commons will have disastrous long-term consequences for the entire world."

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SEE THE BIG STORY • A4

Public spending can work better for the common good, through spending on rejuvenating and expanding critical infrastructure, investing in early child development and renewing areas that experienced economic decline, he suggested.

FINANCE MINISTER LAWRENCE WONG

THE STRAITS TIMES TUESDAY APRIL 19, 2022

From Observation to Action; Validating Cohort Insights

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Observed Insights

Contextualised

Replication Cohort

e.g. S-PRESTO, birth cohorts elsewhere
(Canada, China, France, Japan, Korea, Taiwan, New Zealand, UK, USA)

Implementation & Evaluation

Interventional Trials

- Randomized Controlled Trial (RCT)
- Pre-post Study
- *In silico* simulated trials

Singapore Institute for Clinical Sciences
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child

SUNCARE SG
SUPPORTING THE WELL-BEING OF CHILDREN AND YOUTHS

Early Screening

School Readiness

School Readiness

@Age 4

Whole Child Panel

Peabody Picture Vocabulary Test

This is a test of receptive vocabulary which assesses the child's vocabulary acquisition.

Lollipop Test

This test assesses the child's ability to identify colours, shapes, numbers and letters.

Number Knowledge Test

This test assesses the child's intuitive knowledge of numbers.

Visually Cued Recall Test

This test evaluates the child's working memory through visual images and verbal information.

Random Object Span Test

This test assesses the child's visual working memory.

Comprehensive Test of Phonological Processing- 2

This test evaluates the child's phonological processing as a prerequisite to reading fluency.

+ Panamath

This test measures the child's number sense and approximate number system (ANS) which underlies the ability to produce abstract number representation.

+ Child Behaviour Checklist

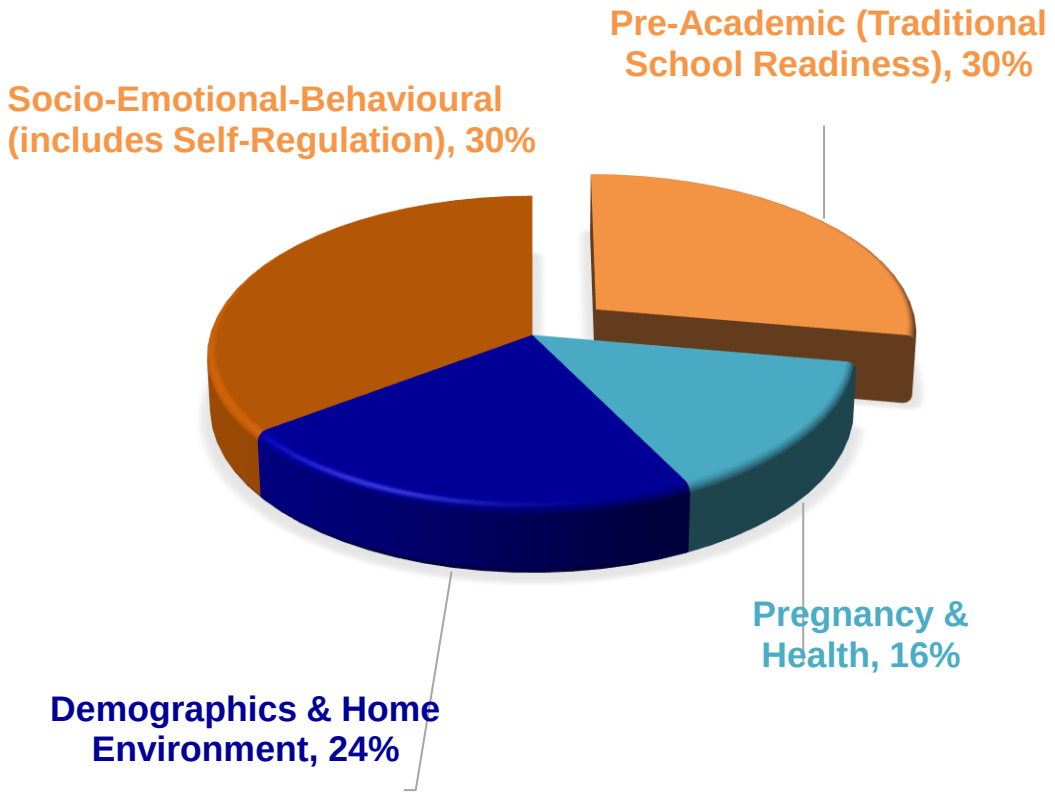
This checklist measures the child's behavioural and socio-emotional functioning as reported by parents.

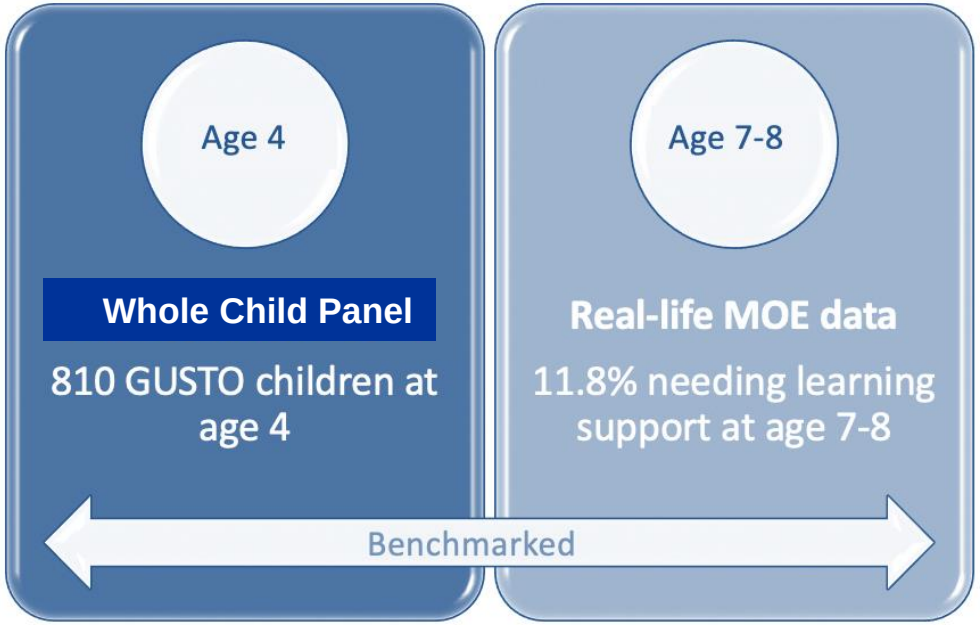
GUSTO

GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

810 GUSTO children were evaluated with the Whole Child Panel at age 4

School Readiness has Multiple Dimensions Transformation of Evaluation to a More Holistic Whole Child Panel





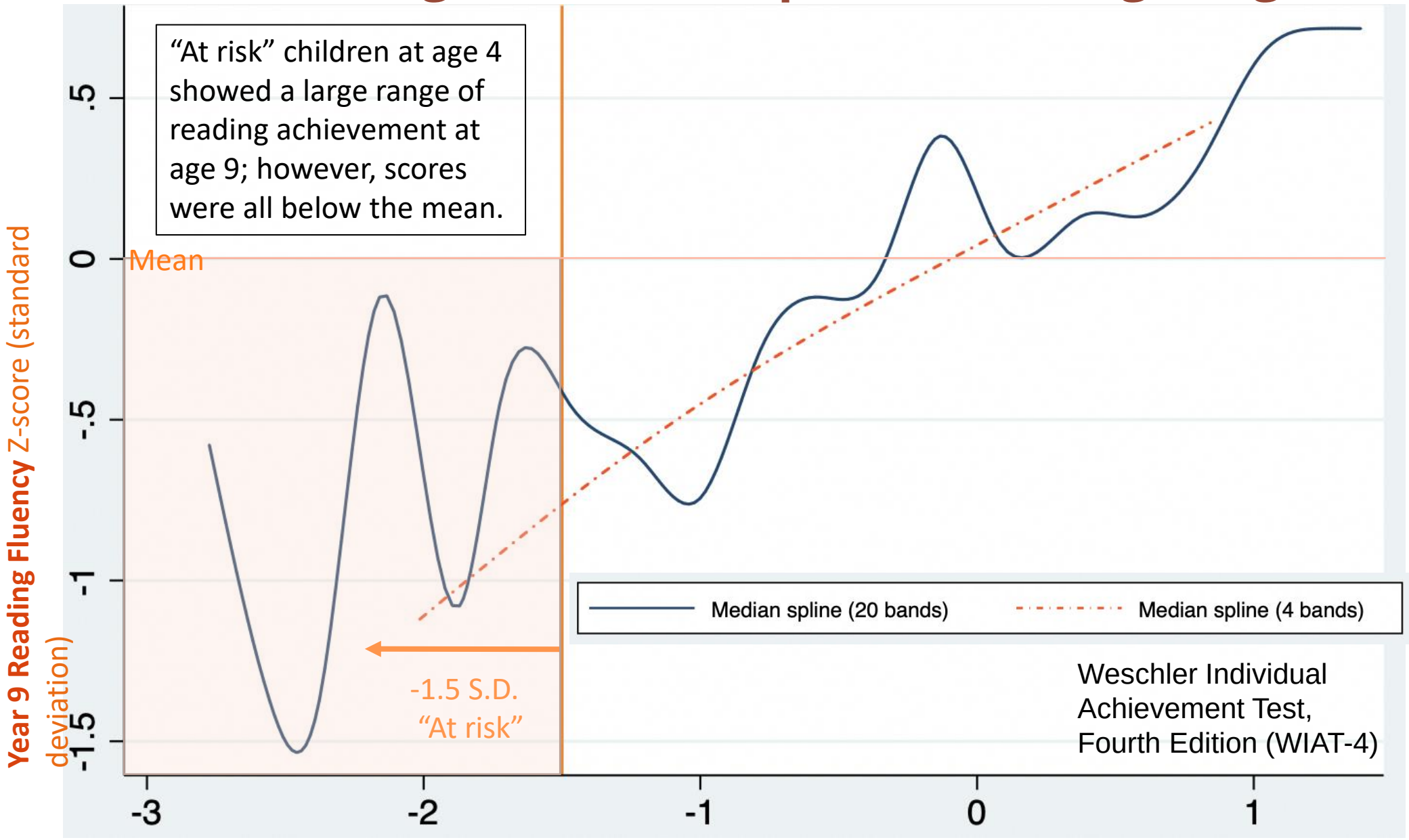
Pre-academic skills alone at age 4 at most explain one-third of the variance in LSP utilization at age 7 to 8. In contrast, family demographics, health and pregnancy, and preschool executive function dimensions contribute 50 to 70 percent in the risk prediction.

Sensitivity 93.5%
Specificity 86.6%
Other existing tests:
Sensitivity/Specificity ~70% only

Working with MOE to refine this

Evelyn Law *et al.* In Press. *Journal of Pediatrics*

“At-risk” children at age 4 remained poor in reading at age 9



Early life factors and reading achievement[1]

Outcome: Poor reading[2]	Odds Ratio	Effect size (Eta-squared η^2)	*p*-value
Household income	3.35	0.10 (medium-large)	<0.001
Maternal education	3.58	0.11 (medium-large)	<0.001
Age 1 screen time (>1 hour/day)	2.83	0.08 (medium)	0.001
Age 4 Whole Child Panel (At-risk)[2]	**23.62**	**0.21 (very large)**	**<0.001**
Age 4.5 Working memory[2]	3.33	0.10 (medium-large)	<0.001
Age 4.5 Selective attention & inhibition[2]	1.81	0.03 (small-medium)	0.01
Age 4.5 Cognitive flexibility[2]	2.51	0.06 (medium)	0.001

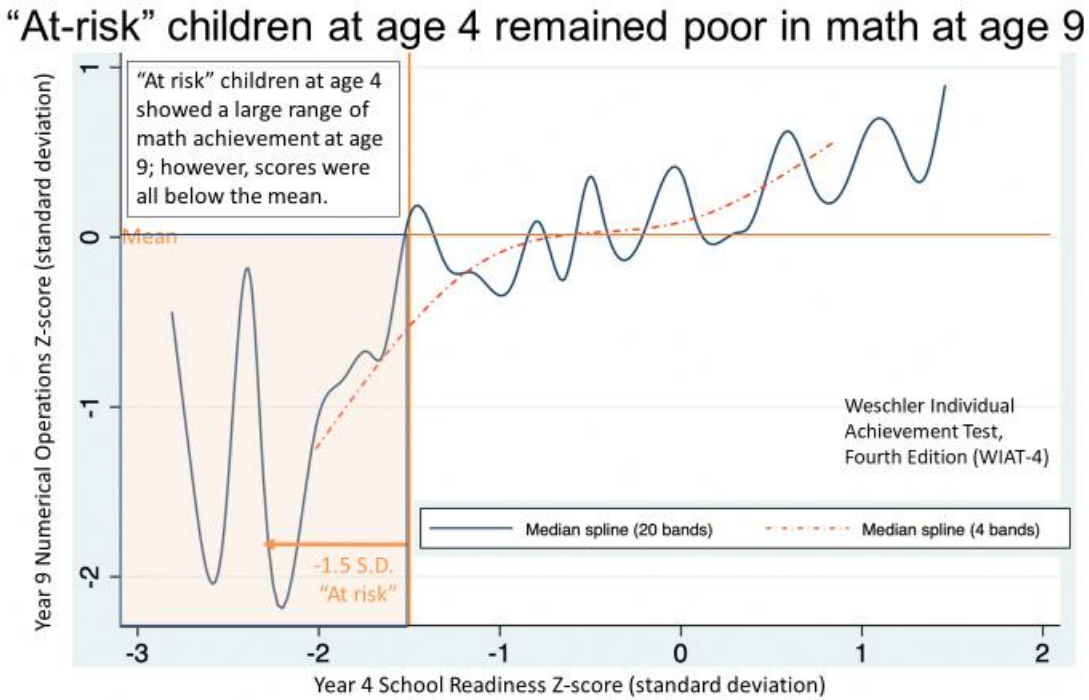
Note:

[1]Weschler Individual Achievement Test, Fourth Edition (WIAT-4)

[2]"At-risk" Whole Child Panel and "poor" math: defined as **>1.5 S.D. below the mean**

η^2 = 0.01, small effect
η^2 = 0.06, medium effect
η^2 = 0.14, large effect

Similar outcomes for math achievement at age 9



Early life factors and math achievement[1]

Outcome: Poor math[2,3]	Odds Ratio	Effect size (Eta-squared η^2)	*p*-value
Household income	4.35	0.14 (large)	<0.001
Maternal education	4.87	0.16 (large)	<0.001
Age 1 screen time (>1 hour/day)	2.71	0.07 (medium)	0.001
Age 4 school readiness (At-risk)[2,3]	**17.62**	**0.21 (very large)**	**<0.001**
Age 4.5 Working memory[2]	3.28	0.10 (medium-large)	<0.001
Age 4.5 Selective attention and inhibition[2]	3.75	0.12 (medium-large)	<0.001
Age 4.5 Cognitive flexibility[2]	2.71	0.07 (medium)	<0.001

Note: [1]Weschler Individual Achievement Test, Fourth Edition (WIAT-4)
[2]"At-risk" school readiness and "poor" math: defined as **>1.5 standard deviations below the mean**
[3]Reference: Not >1.5 standard deviations below the mean

η^2 = 0.01, small effect
η^2 = 0.06, medium effect
η^2 = 0.14, large effect

Taking it to the Community:
Whole Child Panel Pilots with MOE Kindergartens

We are collecting data of children using the GUSTO-led **Whole Child Panel** in pre-academic, self-regulation and socio-emotional abilities before and after the program.

In addition, we are evaluating the effectiveness of **regular self-regulation activities led by teachers in classrooms** as a **scalable** intervention to build children's self-regulation.

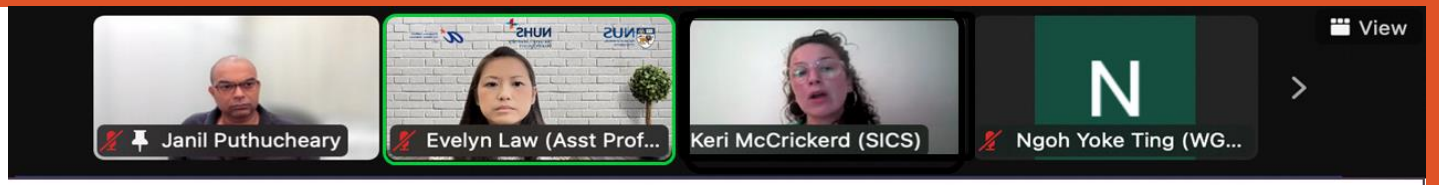
Initial pilot in **4 MOE Kindergartens** (about 350 children) from May 2021, 2-year project

The plan is to implement **intervention activities that can be integrated into everyday practices** and carried out for the **entire class**, **without targeting children** who are more likely to enrol in LSP/LSM when they are in P1. This approach is taken to minimise the risk of stigmatising the weaker children.

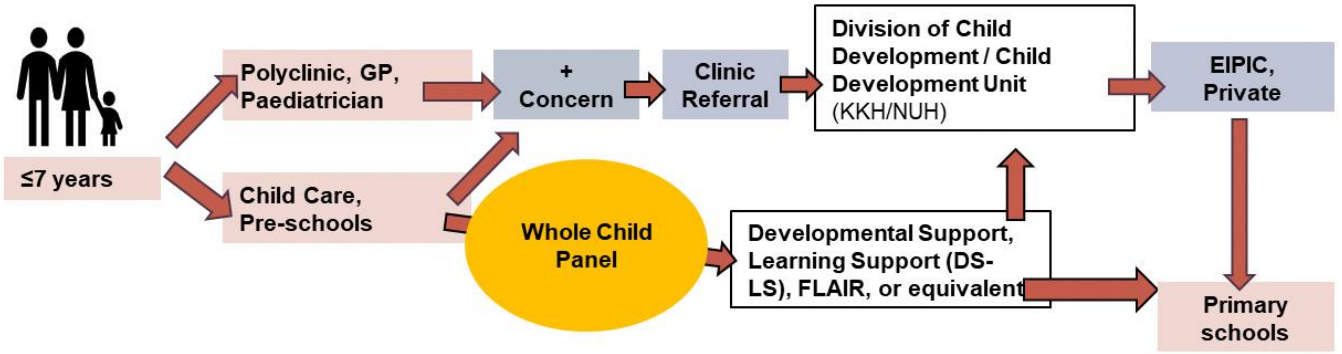
Singapore Institute for Clinical Sciences
SICS

moe KINDERGARTEN

Ministry of Education
SINGAPORE



Scaling up



Current Discussions

- With ECDA, MSF, PCF and NTUC preschool operators
- Developing the Whole Child Panel app for scale up with preschools
- Working with 6 My First Skool, 2 Little Skool House, and 10 PCF preschools with the possibility of spanning all PCF and NTUC operators

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Early Screening

Maternal Emotional Health

Screening for Perinatal Depression

The EPDS is a 10-item questionnaire. Women are asked to answer each question in terms of the past seven days.	
1. I have been able to laugh and see the funny side of things	As much as I always could (score of 0) Not quite so much now (score of 1) Definitely not so much now (score of 2) Not at all (score of 3)
2. I have looked forward with enjoyment to things	As much as I ever did (score of 0) Rather less than I used to (score of 1) Definitely less than I used to (score of 2) Hardly at all (score of 3)
3. I have blamed myself unnecessarily when things went wrong	Yes, most of the time (score of 3) Yes, some of the time (score of 2) Not very often (score of 1) No, never (score of 0)
4. I have been anxious or worried for no good reason	No, not at all (score of 0) Hardly ever (score of 1) Yes, sometimes (score of 2) Yes, very often (score of 3)
5. I have felt scared or panicky for no very good reason	Yes, quite a lot (score of 3) Yes, sometimes (score of 2) No, not much (score of 1) No, not at all (score of 0)
6. Things have been getting on top of me	Yes, most of the time I haven't been able to cope at all (score of 3) Yes, sometimes I haven't been coping as well as usual (score of 2) No, most of the time I have coped quite well (score of 1) No, I have been coping as well as ever (score of 0)
7. I have been so unhappy that I have had difficulty sleeping	Yes, most of the time (score of 3) Yes, sometimes (score of 2) Not very often (score of 1) No, not at all (score of 0)
8. I have felt sad or miserable	Yes, most of the time (score of 3) Yes, quite often (score of 2) Not very often (score of 1) No, not at all (score of 0)
9. I have been so unhappy that I have been crying	Yes, most of the time (score of 3) Yes, quite often (score of 2) Only occasionally (score of 1) No, never (score of 0)
10. The thought of harming myself has occurred to me	Yes, quite often (score of 3) Sometimes (score of 2) Hardly ever (score of 1) Never (score of 0)

Source: Edinburgh Postnatal* Depression Scale (EPDS Cox et al 1987).
(*Developed as the Edinburgh Postnatal Depression Scale but can be used in both pregnancy and postnatal period to assess for possible depression and anxiety. Questions 3, 4 and 5 relate to possible symptoms of anxiety disorders)

Meaney M, Am J Psych, 2018

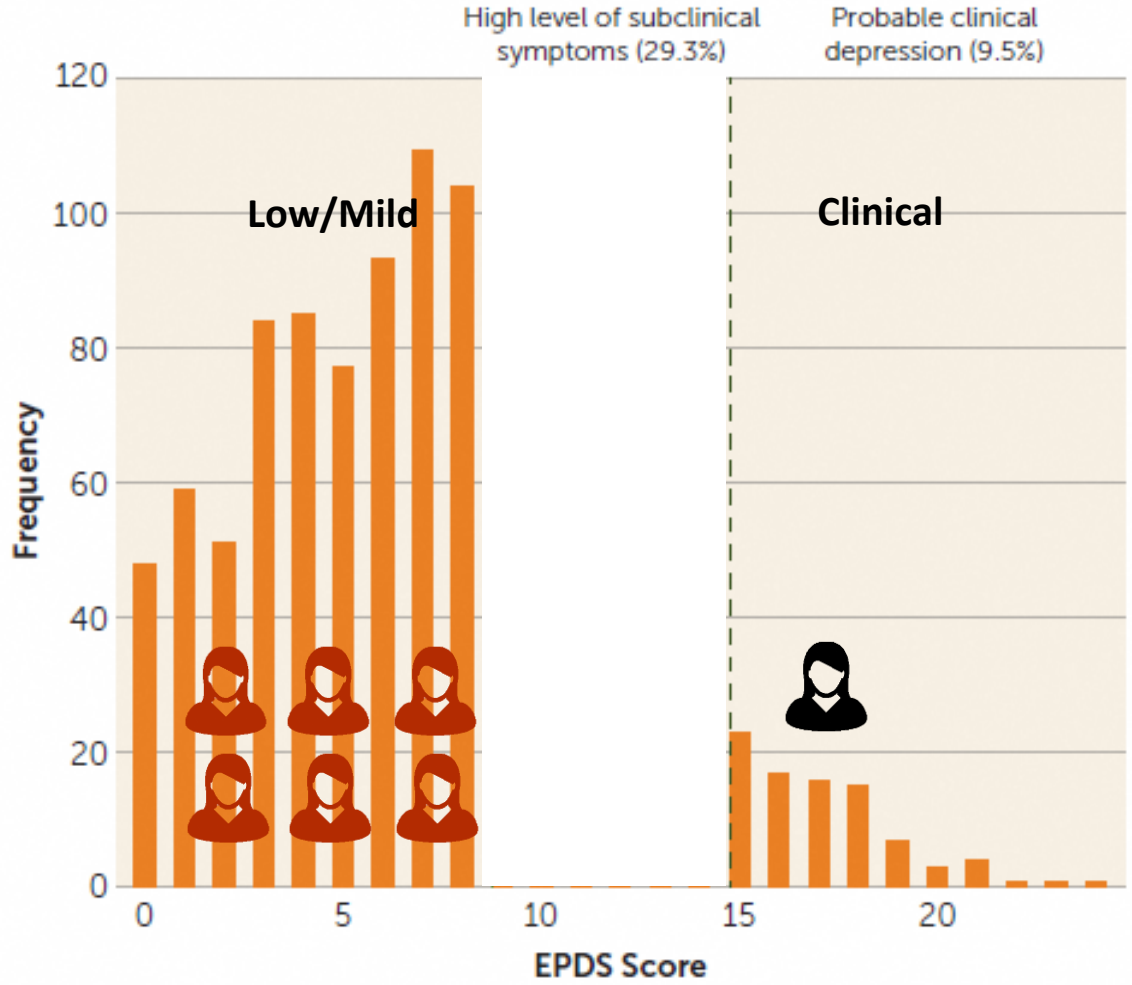
Edinburgh Post-natal Depression Scale (EPDS)

Gestational Week 26 – 28

Late 2nd Trimester

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

4 in 10 Women in GUSTO Show Signs of Perinatal Depression



[a] Probable clinical depression and high subclinical levels of depressive symptoms are based on established cutoffs (scores of 15 or more and of 9 to 13, respectively. The mean score was 7.5 (SD=4.5). The estimated portion of "probable cases" in this study is comparable to those of studies in North American and Western Europe.

Edinburgh Post-natal Depression Scale (EPDS)

Gestational Week 26 – 28

Late 2nd Trimester

Meaney M, Am J Psych, 2018

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Pregnancy and the First 1000 Days
Maternal Mental Stress

Maternal Stress in Pregnancy Affects Subsequent Neurodevelopment of her Child

Brain MRIs conducted across timepoints in early infancy and through childhood, have provided *much insight* into the variations of neurodevelopment

GUSTO is one of the few studies that has brain MRIs from neonates at 1 week of age repeated longitudinally till 10 years of age

This *innovative* approach has demonstrated direct associations between prenatal exposures and subsequent brain development in the growing child

Pregnancy and the First 1000 Days
Maternal Mental Stress

Maternal Stress in Pregnancy Affects Subsequent Neurodevelopment of her Child

ARCHIVAL REPORT

Prenatal Maternal Depression Associates with Microstructure of Right Amygdala in Neonates at Birth

Anne Rifkin-Graboi, Jordan Bai, Helen Chen, Waseem Bak'r Hameed, Lit Wee Sim, Mya Thway Tint, Birit Leutscher-Broekman, Yap-Seng Chong, Peter D. Gluckman, Marielle V. Fortier, Michael J. Meaney, and Anqi Qiu

Background: Antenatal maternal cortisol levels associate with alterations in the amygdala, a structure associated with emotion regulation, in the offspring. However, because offspring brain and behavior are commonly assessed years after birth, the timing of such maternal influences is unclear. This study aimed to examine the association between antenatal maternal depressive symptomatology and neonatal amygdala volume and microstructure and thus establish evidence for the transgenerational transmission of vulnerability for affective disorders during prenatal development.

Methods: Our study recruited Asian mothers at 10 to 13 weeks pregnancy and assessed maternal depression at 26 weeks gestation using the Edinburgh Postnatal Depression Scale. Structural magnetic resonance imaging and diffusion tensor imaging were performed with 157 nonsedated, 6- to 14-day-old newborns and then analyzed to extract the volume, fractional anisotropy, and axial diffusivity values of the amygdala.

Results: Adjusting for household income, maternal age, and smoking exposure, postconceptual age at magnetic resonance imaging, and birth weight, we found significantly lower fractional anisotropy ($p = .009$) and axial diffusivity ($p = .028$), but not volume ($p = .993$), in the right amygdala in the infants of mothers with high compared with those with low-normal Edinburgh Postnatal Depression Scale scores.

Conclusions: The results reveal a significant relation between antenatal maternal depression and the neonatal microstructure of the right amygdala, a brain region closely associated with stress reactivity and vulnerability for mood anxiety disorders. These findings suggest the prenatal transmission of vulnerability for depression from mother to child and that interventions targeting maternal depression should begin early in pregnancy.

Key Words: Affective disorders, amygdala, antenatal depression, diffusion tensor imaging, magnetic resonance imaging, neonatal brain

Depression has a strong familial component. Children of affected parents show a significantly increased risk for depression relative to the normal population (1–3). Likewise, the offspring of depressed mothers show increased evidence for the intermediate phenotypes that associate with vulnerability for depression (4,5), including alterations in brain morphology (6,7). These effects appear to reflect the transgenerational transmission of individual differences in vulnerability for depression. However, the mechanism and timing for such parental influences are unclear and may include genetic vulnerability, antenatal influences upon the uterine milieu, and postnatal parenting practices. Uncertainty with regard to the mechanism of transmission complicates models of risk, as well as the design and timing of preventive interventions.

The importance of environmental influences is underscored by intervention studies demonstrating that effective treatment of depression of mothers of children 7 to 17 years of age decreases psychological problems in the offspring and further suggests effects on parent-child interactions (8). Indeed, depression promotes forms of parenting (9,10) that enhance stress reactivity, social withdrawal, and inattention (11–13), which, in turn, predicts an increased risk for depression. However, there is also evidence for risk transmission during the prenatal period. Depressed mothers exhibit a number of physiological changes that may influence fetal development and include increased and/or prolonged cortisol production (14). Although the placental enzyme 11β-hydroxysteroid dehydrogenase can serve as a partial barrier to maternal cortisol, this enzyme may be overwhelmed when maternal levels are exceptionally high (15). Drawing on evidence from a variety of species, cortisol exerts multiple effects on the brain, including altering neurotransmitter functioning (15); affecting the development of oligodendrocytes, the glia cells that manufacture myelin sheets in the central nervous system (16); and influencing glucocorticoid receptor rich regions such as the amygdala, whose activity may further impact the offspring's own stress hormone and neurotransmitter regulation (17). In humans, antenatal cortisol has been found to be related to increased amygdala volume (18). Likewise, antenatal maternal depression

From the Singapore Institute for Clinical Sciences (AR-G, WBH, BL-B, PDG, MJM, AQ); Department of Bioengineering and Clinical Imaging Research Center (JB, AQ), National University of Singapore; Department of Diagnostic and Interventional Imaging (HC, MVF), KK Women's and Children's Hospital; and Department of Obstetrics & Gynaecology (MIT, BL-B, Y-SC), Yong Loo Lin School of Medicine, National University of Singapore, National University Health System, Singapore, Singapore; and Douglas Mental Health University Institute (MJM), McGill University, Montreal, Canada.

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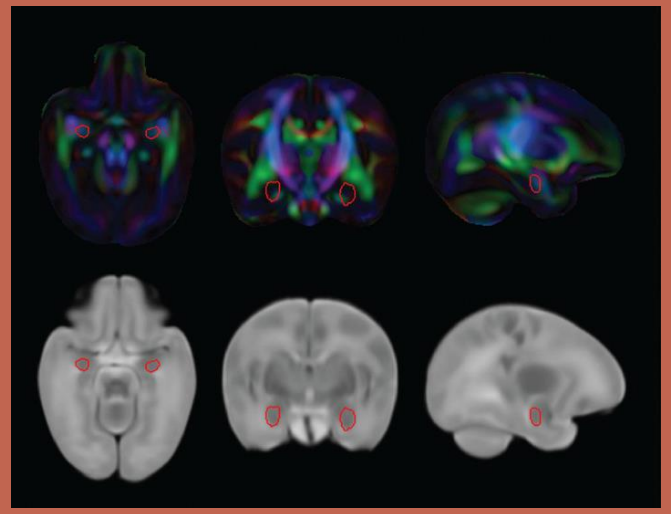
Prenatal maternal depression affects the neonatal microstructure of the *right amygdala*

(a brain region closely associated with vulnerability for mood anxiety disorders)

This suggests transmission of vulnerability for depression from mother to child.

Effect seen at 1 week of life and persists at 4.5 years of age



Perinatal maternal depressive symptoms alter amygdala functional connectivity in girls

Ni Ni Soe[1] | Daniel J. Wen[1] | Joann S. Poh[2] | Yap-Seng Chong[2,3] | Birit Fp Broekman[2] | Helen Chen[4] | Lynette P. Shek[2,5,6] | Kok Hian Tan[7] | Peter D. Gluckman[2] | Marielle V. Fortier[8] | Michael J. Meaney[2,9,10] | Anqi Qiu[1,2]

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ELSEVIER

Biological Psychiatry

Available online 19 August 2013

In Press, Corrected Proof — Note to users

Archival Report

Prenatal Maternal Depression Associates with Microstructure of Right Amygdala in Neonates at Birth

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Pregnancy and the First 1000 Days
Maternal Mental Stress

Maternal Stress in Pregnancy Affects Subsequent Neurodevelopment of her Child

Article

COMT Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology

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Objective: Exposure to antenatal maternal anxiety and complex genetic variations may shape fetal brain development. In particular, the catechol-O-methyltransferase (*COMT*) gene, located on chromosome 22q11.2, regulates catecholamine signaling in the prefrontal cortex and is implicated in anxiety, pain, and stress responsivity. This study examined whether individual single-nucleotide polymorphisms (SNPs) of the *COMT* gene and their haplotypes moderate the association between antenatal maternal anxiety and in utero cortical development.

Method: A total of 146 neonates were genotyped and underwent MRI shortly after birth. Neonatal cortical morphology was characterized using cortical thickness. Antenatal maternal anxiety was assessed using the State-Trait Anxiety Inventory at week 26 of pregnancy.

Results: Individual COMT SNPs (val158met, rs737865, and rs165599) modulated the association between antenatal maternal anxiety and the prefrontal and parietal cortical thickness in neonates. Based on haplotype trend regression analysis, findings also showed that among rs737865-val158met-rs165599 haplotypes, the A-val-G (AGG) haplotype probabilities modulated positive associations of antenatal maternal anxiety with cortical thickness in the right ventrolateral prefrontal cortex and the right superior parietal cortex and precuneus. In contrast, the G-met-A (GAA) haplotype probabilities modulated negative associations of antenatal maternal anxiety with cortical thickness in bilateral precentral gyrus and the dorsolateral prefrontal cortex.

Conclusions: These results suggest that the association between maternal anxiety and in utero neurodevelopment is modified through complex genetic variation in *COMT*. Such genetic moderation may explain, in part, the variation in phenotypic outcomes in offspring associated with maternal emotional well-being.

Am J Psychiatry Qiu et al.; AIA: 1–10

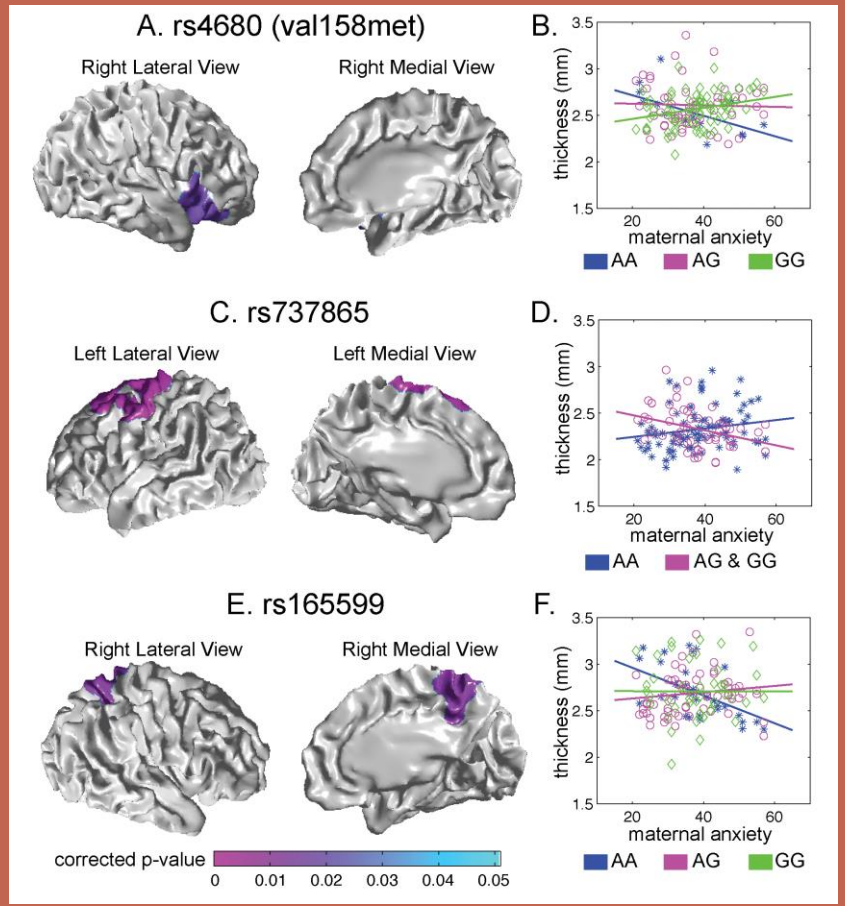
Anxiety has a strong familial component (1). Children of affected parents show an increased risk for emotional problems compared with the normal population (2). While the precise mechanism through which vulnerability is transmitted remains unclear, there is evidence that antenatal maternal emotional well-being associates with alterations in the uterine environment (3) and in fetal physiology (4). Antenatal maternal anxiety and the accompanying alterations in the uterine environment also predict an increased risk for childhood behavioral and emotional problems (3), decreased gray matter density of prefrontal and sensory cortices in childhood (5, 6), and alterations in performance on prefrontal dependent tasks (5). Importantly, the associations of antenatal maternal anxiety with childhood emotional function (7) and early brain growth, particularly in structures that are implicated in the regulation of emotional states (8), are independent of postnatal maternal anxiety. These findings appear to reflect a prenatal, transgenerational transmission of individual differences in vulnerability for emotional problems.

Vulnerability for anxiety disorders in children of affected parents may also be moderated through genetic variations (9). The catechol-O-methyl transferase (*COMT*) gene, located on chromosome 22q11.2, is well expressed across the brain before birth. The *COMT* gene starts its expression in the prefrontal cortex at infancy and peaks during early adulthood (10, 11). It regulates catecholamine signaling, particularly dopamine signaling, in the prefrontal cortex and is associated with the development of the prefrontal anatomy and function (12). It has been suggested that *COMT* variants are molecular genetic markers associated with anxiety, pain, and stress responsivity (13). A functional single-nucleotide polymorphism (SNP) of the *COMT* gene (rs4680) leads to an amino acid change from valine (*val*) to methionine (*met*) at position 158 (val158met) (14). The *val* allele is suggested as a predominant factor that determines higher *COMT* activity in the prefrontal cortex, which presumably leads to lower synaptic dopamine levels through enhanced degradation (15). The *COMT* genotype is associated with morphological changes of prefrontal, temporal, and superior parietal regions in neonates (16) and adolescents

Prenatal maternal anxiety affects the *prefrontal and parietal cortical thicknesses* of neonatal brains

(involved in executive functioning & sensory processing)

This association is modulated by the infants' COMT haplotypes
(val158met, rs737865, and rs165599)



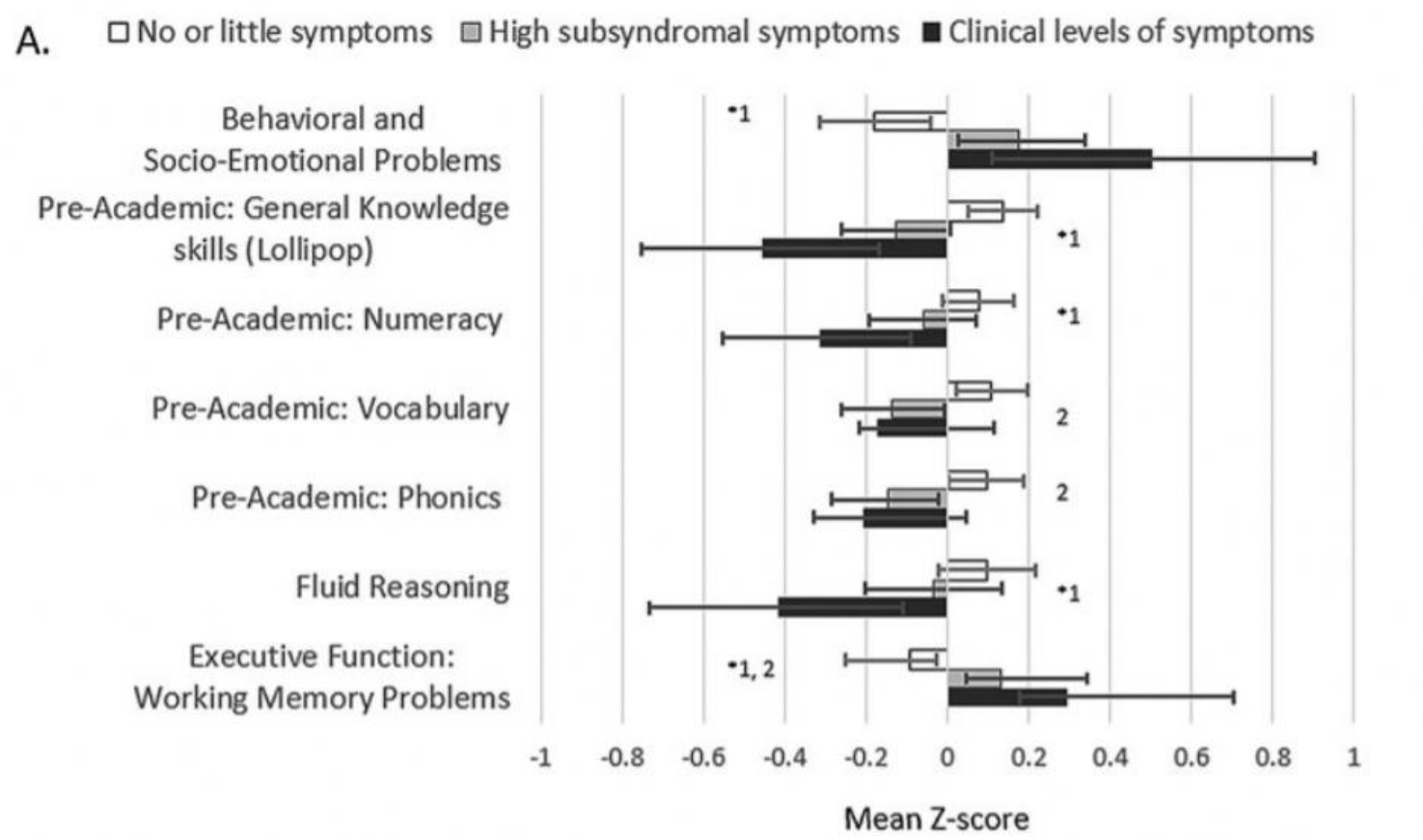
Enriching the Preschool Years

Improving Human Potential through the Early Environment

Identifying Gaps Early

The *Whole Child Panel*, a **locally validated assessment tool**, can identify potential gaps in pre-academic, social and executive function skillsets as early as **4 years of age** when interventions may have more impact

School readiness in a child is impaired when mum is depressed during pregnancy



Law EC et al (2021). Income disparity in school readiness and the mediating role of perinatal maternal mental health: a longitudinal birth cohort study. Epidemiology and Psychiatric Sciences 30,e6, 1-12.

EVIDENCE INSIGHT | EI001 / APRIL 2021

child CENTRE FOR HOLISTIC INITIATIVES FOR LEARNING & DEVELOPMENT

Maternal mental health and well-being during pregnancy linked to brain development and function in children

KEY POINTS:

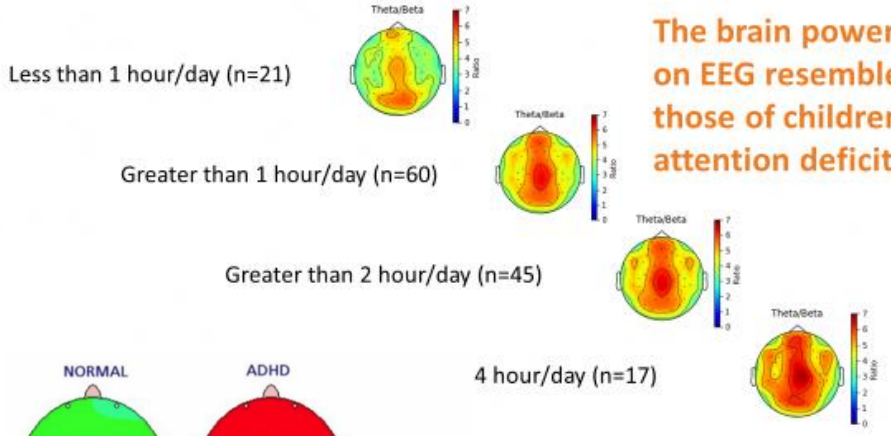
- Research from GUSTO (Growing Up in Singapore Towards healthy Outcomes) shows that distress during pregnancy—even at mild to moderate levels—can affect the development and function of the child with respect to a wide range of cognitive and emotional outcomes.
- These outcomes include executive functions that emerge early in life and are determinants of both academic performance and mental health.
- As such, these functions are critical for successful passage through life, and its impairment places the individual at lifelong disadvantage.
- Importantly, S-PRESTO (Singapore Preconception Study of long-Term maternal and child Outcomes) findings show that relevant levels of maternal mental health problems pre-date conception and remain stable over the course of pregnancy and following birth.
- Interventions need to focus on the mother and infant, with parental needs being supported even before the child is born.

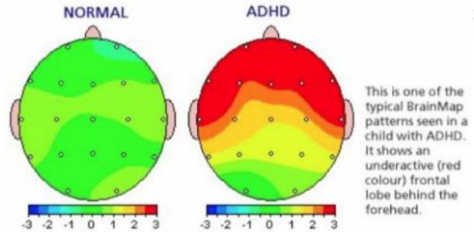
Screen Time

Early Childhood Environment

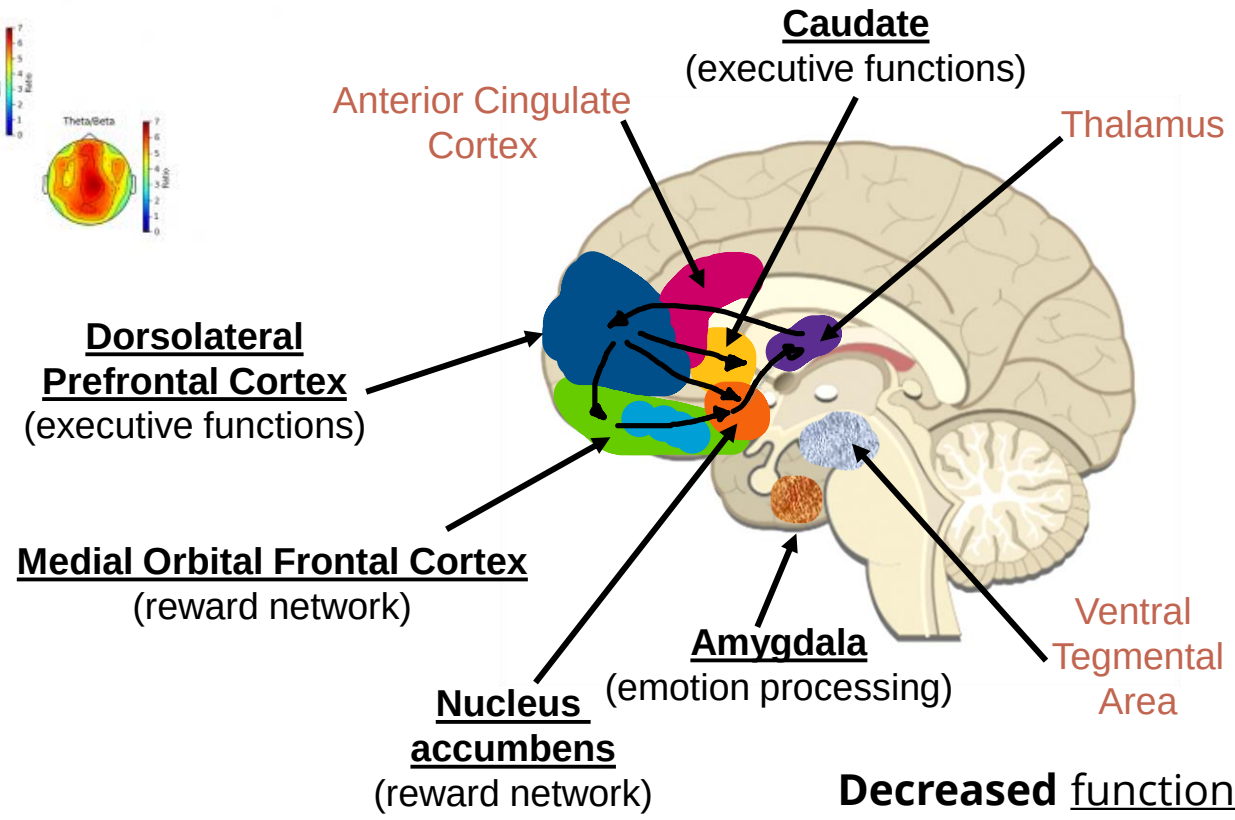
Effect of Screen Time During Infancy on Neurodevelopment

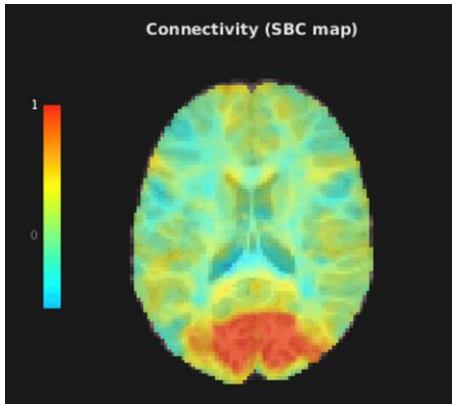
EEG studies suggest attention problems at 18 months





With screen time exposure in infancy, we are already noting significant differences in **brain structures and connections** through MRI views of the **child at age 6**





Underlined structures affected by infant screen time all involved in executive functions, reward processing and emotional processing.

Decreased functional connectivity within the reward network suggests **poorer** cognitive control in reward-based decision making.

Enriching the Preschool Years

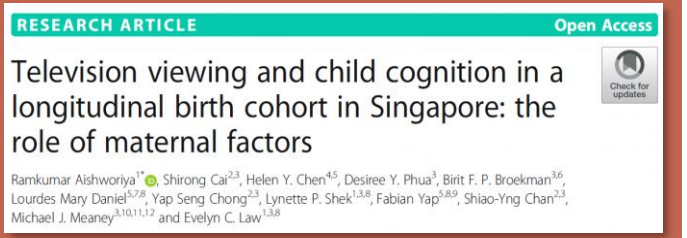
Improving Human Potential through the Early Environment

Adverse Effects of Screen Time

Excessive and inappropriate digital media use may pose a threat to developing minds

Risk Factors

- Lower Maternal Education
- Suboptimal Maternal Mental Health



RESEARCH ARTICLE Open Access

Television viewing and child cognition in a longitudinal birth cohort in Singapore: the role of maternal factors

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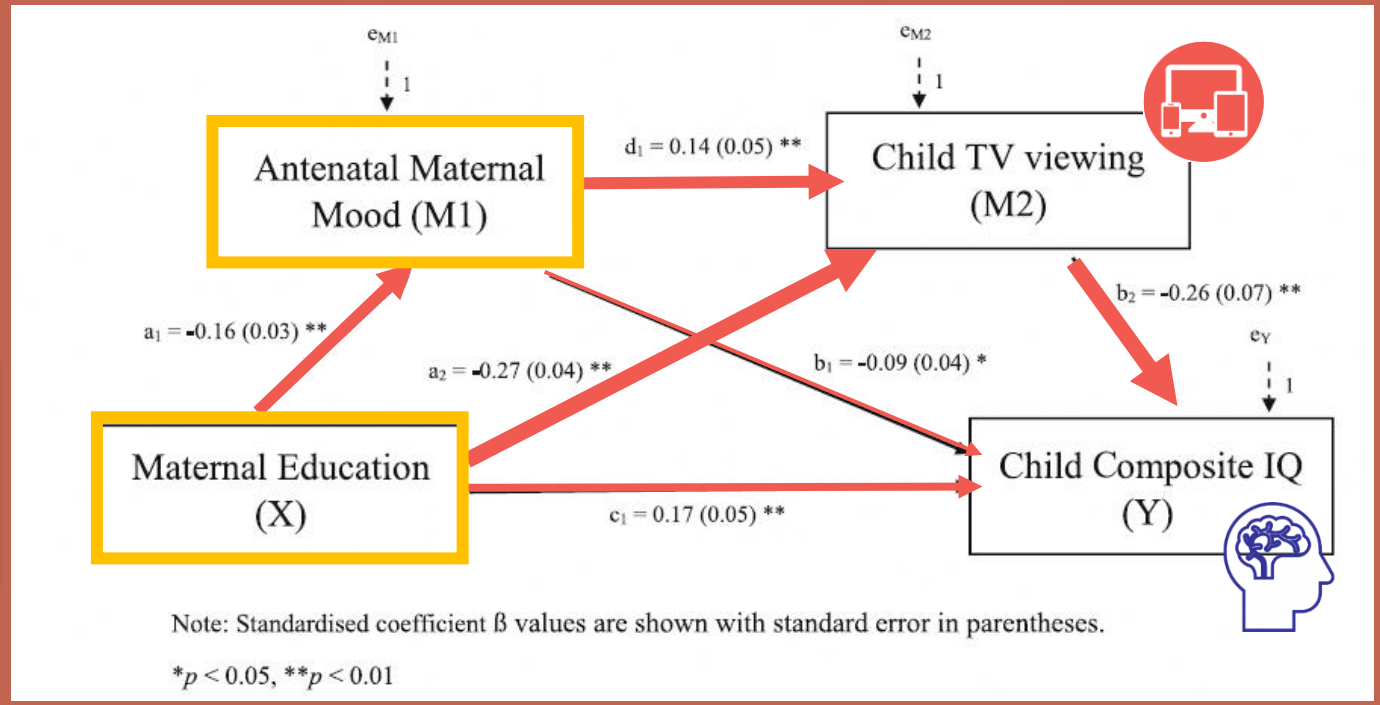

Every 1 hour extra TV viewing time in infancy is associated with **-1.55 IQ points** at 4.5 years of age
Odds of having an IQ score <70 (threshold for intellectual disability)
was 6.2 times higher among children who watched >1 h/day of TV

Local study: Excessive screen time in young children affects brain executive function development

Research

JAMA Pediatrics | Original Investigation

Associations Between Infant Screen Use, Electroencephalography Markers, and Cognitive Outcomes

Evelyn C. Law, MD; Meredith X. Han, BSc; Zhuoyuan Lai, BSc; Shuping Lim, MSc; Zi Yan Ong, BA; Valerie Ng, BA; Laurel J. Gabard-Durnam, PhD; Carol L. Wilkinson, MD, PhD; April R. Levin, MD; Anne Rifkin-Graboi, PhD; L. Mary Daniel, MBBS, MMed; Peter D. Gluckman, MBChB, DSc; Yap Seng Chong, MBBS, MD; Michael J. Meaney, PhD; Charles A. Nelson, PhD

IMPORTANCE Research evidence is mounting for the association between infant screen use and negative cognitive outcomes related to attention and executive functions. The nature, timing, and persistence of screen time exposure on neural functions are currently unknown. Electroencephalography (EEG) permits elucidation of the neural correlates associated with cognitive impairments.

OBJECTIVE To examine the associations between infant screen time, EEG markers, and school-age cognitive outcomes using mediation analysis with structural equation modeling.

DESIGN, SETTING, AND PARTICIPANTS This prospective maternal-child dyad cohort study included participants from the population-based study Growing Up in Singapore Toward Healthy Outcomes (GUSTO). Pregnant mothers were enrolled in their first trimester from June 2009 through December 2010. A subset of children who completed neurodevelopmental visits at ages 12 months and 9 years had EEG performed at age 18 months. Data were reported from 3 time points at ages 12 months, 18 months, and 9 years. Mediation analyses were used to investigate how neural correlates were involved in the paths from infant screen time to the latent construct of attention and executive functioning. Data for this study were collected from November 2010 to March 2020 and were analyzed between October 2021 and May 2022.

EXPOSURES Parent-reported screen time at age 12 months.

MAIN OUTCOMES AND MEASURES Power spectral density from EEG was collected at age 18 months. Child attention and executive functions were measured with teacher-reported questionnaires and objective laboratory-based tasks at age 9 years.

Supplemental content

A local longitudinal study analyzed the growth data of 506 children and confirmed that excessive screen time in infants and young children is associated with adverse cognitive function, and the situation is still obvious after the children are eight years old.

THE STRAITS TIMES February 1, 2023

Screen time for children may affect future learning: Study

Increased screen time for infants linked to impaired brain function and may have lasting detrimental effects

Ng Wei Kai

Excessive screen time for young children is linked to impaired brain function and may have detrimental effects that last beyond early childhood and impair future learning, a new study has shown.

The study of 506 children showed that infants who were exposed to more screen time had more "low-frequency" brain waves – a state that is correlated with lack of cognitive alertness.

As the duration of screen time they were exposed to increased, more altered brain activity and more cognitive deficits were measured in the children, and these effects continue after the child reaches eight years old, the study said.

Children with deficits in executive function often have difficulty controlling impulses or emotions, sustaining attention, following through multi-step instructions, and persisting in hard tasks.

The study, conducted by researchers from the National University of Singapore (NUS), the Singapore Institute for Clinical Sciences (SICS), the National Institute of Education, KK Women's and Children's Hospital, McGill University, and Harvard Medical School was published on Tuesday in the peer-reviewed medical journal JAMA Pediatrics.

Lead author, Dr Evelyn Law from NUS Medicine and SICS' Translational Neuroscience Programme, said: "The study provides compelling evidence to existing studies that our children's screen time needs to be closely monitored, particularly during early brain development."

The children studied were those enrolled in the Growing Up in Singapore Towards Healthy Outcomes (Gusto) cohort study and have been so since birth.

In a joint statement on Monday, NUS and SICS said the brain of a child grows rapidly from birth until early childhood, but the part of the brain which controls executive functioning, known as the prefrontal cortex, has a longer development period.

Executive functions include the ability to sustain attention, process information and regulate emotional states, all of which are essential for learning and school performance, it said.

It added that the advantage of this slower growth in the prefrontal cortex is that the gaining and shaping of executive function skills can happen across the school years until higher education.

The statement added: "However, this same area of the brain responsible for executive functioning skills is also highly vulnerable to environmental influences over an extended period of time.

"This study points to excessive screen time as one of the environmental influences that may interfere with executive function development."

Prior research suggests that infants have trouble processing information on a two-dimensional screen, it said.

"When watching a screen, the infant is bombarded with a stream of fast-paced movements, ongoing blinking lights and scene changes, which require ample cognitive resources to make sense of and process. The brain becomes 'overwhelmed' and is unable to leave adequate resources for itself to mature in cognitive skills such as executive functions."

The statement added that the researchers are also concerned that families which allow very young children to have hours of screen time often face additional challenges. These include stressors such as food or housing insecurity, and parental mood problems.

More work needs to be done to understand the reasons behind excessive screen time in young children, it said, and further efforts are necessary to distinguish the direct association of infant screen use versus family factors that predispose early screen use.

Professor Chong Yap Seng, dean of NUS Medicine and chief clinical officer at SICS, said: "These findings should not be taken lightly because they have an impact on the potential development of future generations and human capital.

"With these results, we are one step closer towards better understanding how environmental influence can affect the health and development of children. This would allow us to make more informed decisions in improving the health and potential of every Singaporean."

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The study showed that infants who were exposed to more screen time had more "low-frequency" brain waves – which is correlated with lack of cognitive alertness.

Researchers measured impact at 12 months, 18 months and 9 years

When children in the study were 12 months old, parents were asked to report the average amount of screen time consumed on weekdays and weekends each week.

The children were then classified into four groups based on screen time per day – less than one hour, one to two hours, two to four hours, and more than four hours.

When the children were 18 months old, researchers measured brain activity using electroencephalography (EEG), a tool which tracks changes in brain activity.

Each child also participated in various cognitive ability tests that measured his or her attention span and executive functioning – sometimes referred to as self-regulation skills – at the age of nine years, the National University of Singapore and Singapore Institute for Clinical Sciences said in a statement on Monday.

The team first examined the association between screen time and EEG brain activity.

The EEG readings revealed that infants who were exposed to longer screen time had greater "low-frequency" waves, a state that correlated with lack of cognitive alertness.

To find out whether screen time and the changes observed in the brain activity had any adverse outcomes during later childhood, the research team analysed the data across three points for the same children – at 12 months, 18 months and nine years.

It said: "As the duration of screen time increased, the greater the altered brain activity and more cognitive deficits were measured."

Ng Wei Kai

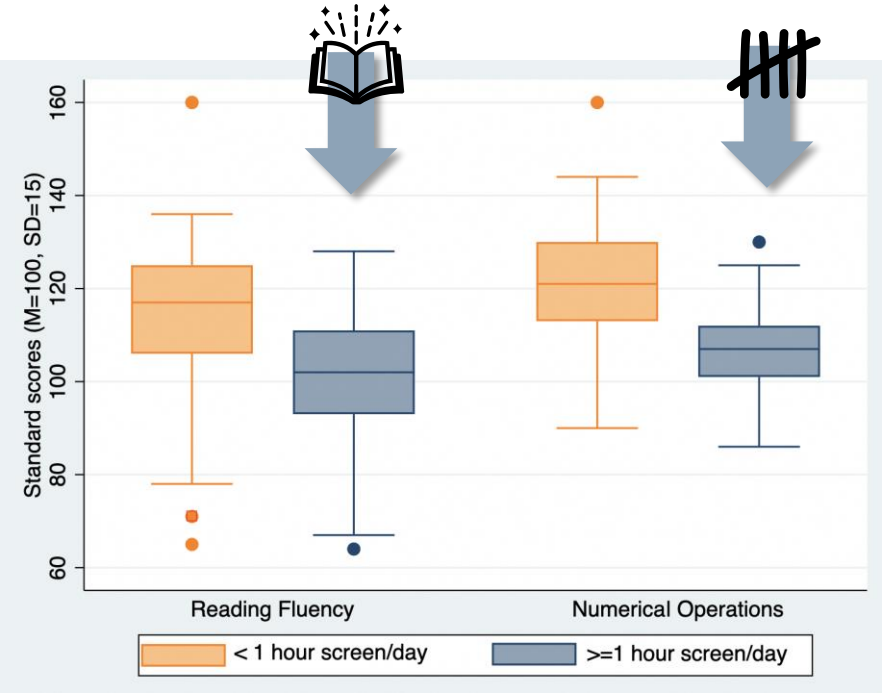
ISSUES WITH PROCESSING INFORMATION

When watching a screen, the infant is bombarded with a stream of fast-paced movements, ongoing blinking lights and scene changes, which require ample cognitive resources to make sense of and process. The brain becomes 'overwhelmed' and is unable to leave adequate resources for itself to mature in cognitive skills such as executive functions.

NATIONAL UNIVERSITY OF SINGAPORE AND SINGAPORE INSTITUTE FOR CLINICAL SCIENCES, in a statement.

The negative effects of screen time during infancy, extend to later childhood

Academic performance at age 9 is weaker, in children with >1h screen time/day as infants



Attention & Executive Function is poorer at age 9, with higher screen exposure as infants

Table 2. Infant Screen Time and Its Association With 9-Year Attention and Executive Functioning in Regression Models[a]

Cognitive domain	Cognitive problem or skill	Report or task	*t*	Coefficient (95% CI)	SE	η^2
Attention	Attention problem[b]	Teacher report	2.87	1.06 (0.31 to 1.81)	0.37	0.09
Executive functioning	General executive control problem[c]	Teacher report	2.30	1.72 (0.21 to 3.23)	0.75	0.08
	Inhibition[d]	Task	−2.96	−0.56 (−0.94 to −0.19)	0.23	0.16
	Shifting[d]	Task	−3.12	−0.56 (−0.91 to −0.20)	0.18	0.16
	Working memory recall[d]	Task	−2.12	−0.30 (−0.58 to −0.02)	0.14	0.03

Abbreviations: BRIEF-2, Behavior Rating Inventory of Executive Function, second edition; CBCL, Child Behavior Checklist; NEPSY-II, Developmental Neuropsychological Assessment, second edition.

[a] Adjusted for covariates including household income, birth weight, smoking exposure during pregnancy, child sex, and antenatal maternal mental health factor.

[b] *t* Scores (mean [SD], 50 [10]) from the CBCL Attention Problem.

[c] *t* Score from the BRIEF-2 General Executive Control Problems.

[d] NEPSY-II scaled scores (mean [SD], 10 [3]).

JAMA Pediatrics | Original Investigation

Associations Between Infant Screen Use, Electroencephalography Markers, and Cognitive Outcomes

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JAMA Pediatrics, Jan 2023

We used a combination of measures to establish a broad view of the impairments

- Teacher-reported attentional behaviours
- Lab-based gold-standard cognitive and academic assessments
- Brain electrical activity measures through EEGs

EVIDENCE INSIGHT | EI002 / JULY 2021

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Impact of screen viewing during early childhood on cognitive development

KEY POINTS:

- Research from the GUSTO (Growing Up in Singapore Towards healthy Outcomes) study of mothers and children shows that, locally, almost all infants and toddlers ages two and under are exposed to approximately 2 hours per day of digital media via electronic screen-based devices.
- High levels of screen time during the early years can affect cognitive development and executive functioning in later childhood.
- Moreover, high levels of screen time in children under the age of two are associated with the development of a sedentary lifestyle in later life, which is then associated with obesity, high blood pressure, and poorer mental health.
- Based on current evidence, no passive screen viewing time is recommended for children below 18 months. Children 18 to 36 months should have limited unsupervised passive screen viewing of not more than one hour per day.

Why is the issue of high levels of screen time important for a child's development and health?

Advances in digital technology have created greater opportunities for infants and toddlers to engage with digital media[1]. Screen time refers to activities undertaken with electronic devices, such as phones, tablets, computers, and televisions. Infants can focus on a screen from an early age and children as young as 6 months of age are now regularly being exposed to electronic screens, often serving merely as pacifiers. In Singapore, many infants and toddlers ages 2 and under are exposed regularly to digital media. By the age of 18 to 24 months, about 90% of children are engaged in daily passive viewing of screens (passive viewing refers to screen viewing without adult co-viewing and interaction)[2]. This is comparable to findings from studies undertaken in other countries[3,4,5]. Recent data suggest that high amounts of passive screen viewing in early childhood

Early Eating Behaviours

Early Childhood Environment

Adults are getting fitter, but children are increasingly overweight: MOH figures

13 per cent of children in mainstream schools were overweight in 2017, a slight rise from the 11 per cent in 20

PUBLISHED MAR 14, 2018, 9:27 PM SGT | UPDATED MAR 15, 2018, 4:28 PM

SINGAPORE

Child obesity rates shoot up in Singapore

LINETTE LAI, THE STRAITS TIMES
Oct 12, 2017 06:00 am

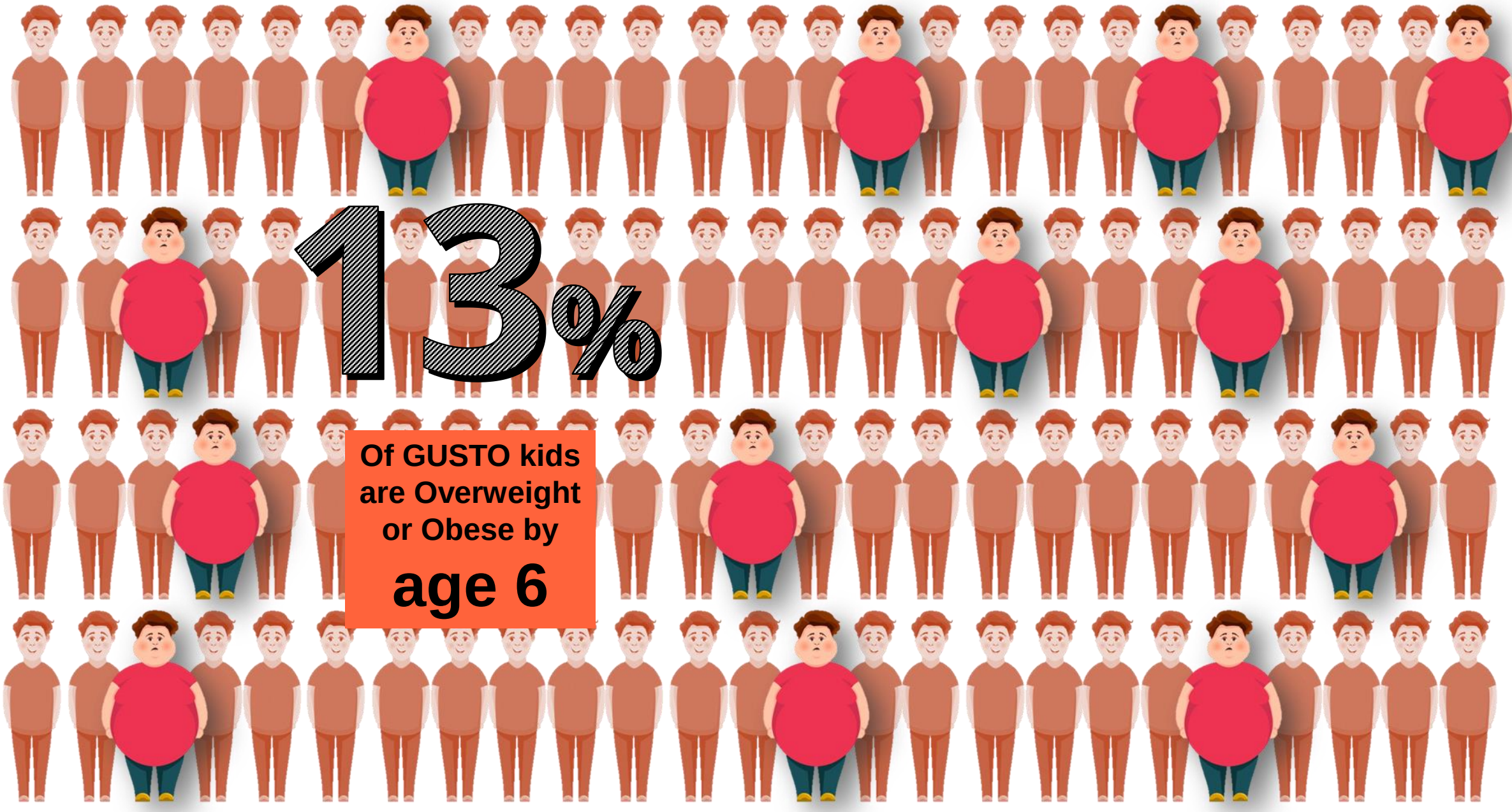
The proportion of overweight children in Singapore has shot up over the past four decades.

In 1976, 1.4 per cent of Primary 1 pupils were overweight or obese, as were 2.2 per cent of Primary 6 pupils.

By 2006, this had gone up to 12.7 per cent and 15.9 per cent respectively. Obesity rates among school-going children in general stood at 12 per cent in 2014.

This is in line with a major study published yesterday, which showed that the number of obese children and adolescents worldwide has jumped tenfold over the past 40 years.

TNP PHOTO ILLUSTRATION


13%
Of GUSTO kids are Overweight or Obese by
age 6

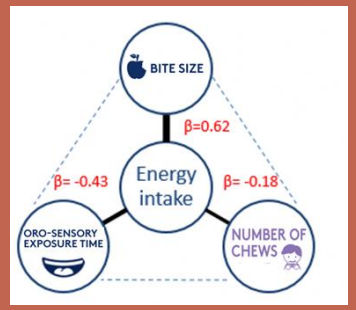
Enriching the Preschool Years

Improving Human Potential through the Early Environment

Addressing the Gaps: Improving Eating Behaviours

Eating Speed

Obesogenic Childhood Eating Behaviours can be Identified



Faster eating at age 4.5 predicted higher BMI and adiposity at age 6

Children taken care of by **non-parental caregivers** have **higher adiposity** measures.

Children with early signs of Eating in the Absence of Hunger (EAH) at age 4.5 were **3X more likely** to exhibit similar traits later (age 6), showing stability over time

Eating in the Absence of Hunger

The preschool years or earlier are a golden opportunity to set up habits for a lifetime

Portion Size

Caregivers' preferences (for themselves) can **bias** the portion sizes they pick for their child

By 6 years of age, the strongest predictor of **child energy intake** was the total **portion** they served **themselves**

Children learn to **'plate clean'** during the **preschool** years

Regardless of risk factors for obesity, children do not become obese unless they have inappropriate eating behaviours

Eating behaviors moderate the associations between risk factors in the first 1000 days and adiposity outcomes at 6 years of age

Anna Fogel,[1] Keri McCrickerd,[1] Izzuddin M Aris,[2] Ai Ting Goh,[1] Yap-Seng Chong,[3,4] Kok Hian Tan,[5] Fabian Yap,[5] Lynette P Shek,[3,6] Michael J Meaney,[3,7,8] Birit FP Broekman,[3,9] Keith M Godfrey,[10] Mary FF Chong,[1,11] Shirong Cai,[3,4] Wei Wei Pang,[4] Wen Lun Yuan,[6] Yung Seng Lee,[3,6] and Ciarán G Forde[1,12]

[1]Clinical Nutrition Research Centre, Singapore Institute for Clinical Sciences, Agency for Science, Technology and Research (A*STAR), National University Health System, Singapore; [2]Division of Chronic Disease Research Across the Lifecourse, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, MA, USA; [3]Singapore Institute for Clinical Sciences, Agency for Science, Technology and Research (A*STAR), Singapore; [4]Department of Obstetrics and Gynaecology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; [5]Department of Maternal Fetal Medicine, KK Women's and Children's Hospital,Singapore; [6]Department of Paediatrics, Yong Loo Lin School of Medicine, National University of Singapore, Singapore; [7]Department of Psychiatry, McGill University & Sackler Institute for Epigenetics & Psychobiology at McGill University, Montreal, Quebec, Canada; [8]Ludmer Centre for Neuroinformatics and Mental Health, Douglas Mental Health University Institute, Montreal, Quebec, Canada; [9]Department of Psychiatry, VU Medical Centre, VU University, Amsterdam, Netherlands; [10]Medical Research Council Lifecourse Epidemiology Unit and National Institute for Health Research Southampton Biomedical Research Centre, University of Southampton and University Hospital Southampton NHS Foundation Trust, Southampton, United Kingdom; [11]Saw Swee Hock School of Public Health, National University of Singapore, Singapore; and [12]Department of Physiology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

ABSTRACT

Background: Several risk factors in the first 1000 d are linked with increased obesity risk in later childhood. The role of potentially modifiable eating behaviors in this association is unclear.

Objectives: This study examined whether the association between cumulated risk factors in the first 1000 d and adiposity at 6 y is moderated by eating behaviors.

Methods: Participants were 302 children from the GUSTO (Growing Up in Singapore Towards healthy Outcomes) cohort. Risk factors included maternal prepregnancy and paternal overweight, excessive gestational weight gain, raised fasting plasma glucose during pregnancy, short breastfeeding duration, and early introduction of solid foods. Composite risk scores reflecting the prevalence and the importance of the risk factors present were computed. Adiposity outcomes were child BMI and sum of skinfolds (SSF), and candidate eating behavior moderators were portion size, eating rate, and energy intake during lunch and in an eating in the absence of hunger task.

Results: Higher composite risk score predicted higher BMI *z* scores (B = 0.08; 95% CI: 0.04, 0.13) and larger SSF (0.70 mm; 0.23, 1.18 mm), and was associated with larger self-served food portions (5.03 kcal; 0.47, 9.60 kcal), faster eating rates (0.40 g/min; 0.21, 0.59 g/min), and larger lunch intakes (7.05 kcal; 3.37, 10.74 kcal). Importantly, the association between composite risk score and adiposity was moderated by eating behaviors. The composite risk score was unrelated to SSF in children who selected smaller food portions, ate slower, and consumed less energy, but was positively associated with SSF among children who selected larger food portions, ate faster, and consumed more energy (eating behavior × risk score interactions: $P < 0.05$).

Conclusions: The association between risk factors in the first 1000 d and adiposity at 6 y varies by eating behaviors, highlighting modifiable behavioral targets for interventions. This trial was registered at clinicaltrials.gov as NCT01174875. *Am J Clin Nutr* 2020;111:997–1006.

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Supplemental Tables 1–3 and Supplemental Figure 1 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/ajcn/.

Data described in the article, code book, and analytic code will be made available upon request pending application.

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Abbreviations used: BMIz, BMI *z* score; EAH, eating in the absence of hunger; eGWG, excessive gestational weight gain; FPG, fasting plasma glucose; GUSTO, Growing Up in Singapore Towards healthy Outcomes; PPO, prepregnancy overweight/obesity; SES, socioeconomic status; SSF, sum of skinfolds.

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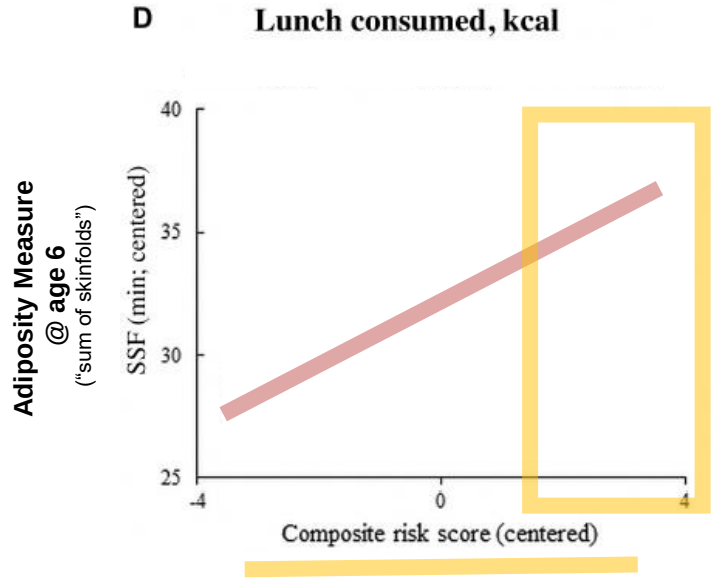


N=392, *corrected P<0.05

13%

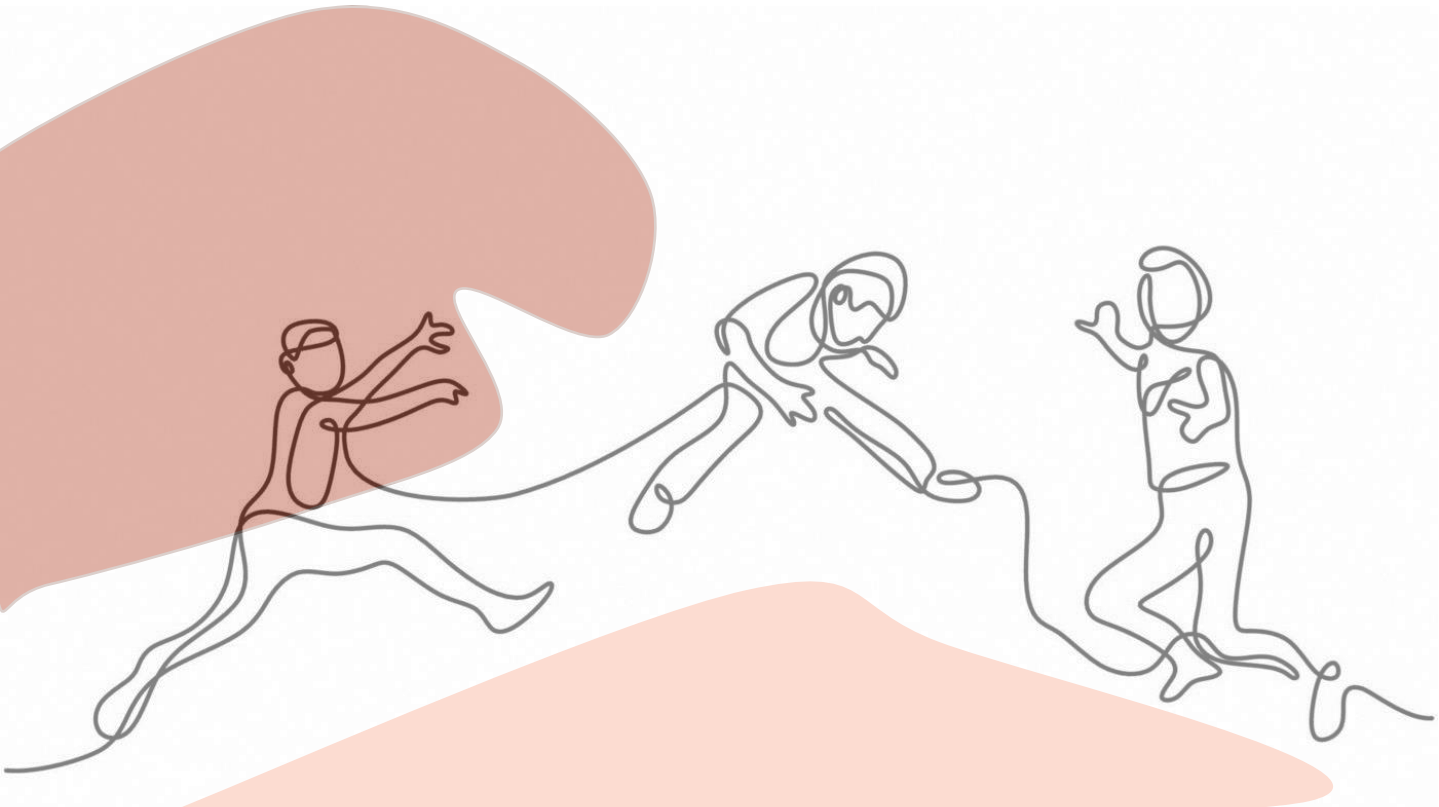
of GUSTO kids are overweight/obese by age 6

Children in the highest risk groups had inherent risk factors - both parents were overweight, and mothers had excess gestational weight gain (GWG) and high glycemia (FPG) in pregnancy

However, these inherent risk factors were in themselves, insufficient, and **had to be combined with inappropriate eating behaviours to result in greater adiposity**

Levels of obesogenic eating behaviour

Lower — Medium ····· Higher



THE STRAITS TIMES FRIDAY OCTOBER 28, 2022

Pre-school kids taught to eat what they need, not what they can

Joyce Teo
Senior Health Correspondent

A trial programme aimed at tackling obesity teaches pre-school children to eat according to how hungry they are instead of how much food there is or being pressured to finish their meals.

The trial, which was mentioned at a child development conference on Thursday, is being carried out at six childcare centres in Singapore. It involves 205 children aged between three and six, and their caregivers.

The Appetite Toolbox (ATB) programme was developed from the findings of the Growing Up In Singapore Towards Healthy Outcomes (Gusto) study. This longitudinal study showed that larger serving sizes, eating faster and impulsive eating are associated with increased food intake and the likelihood of developing an unhealthy body weight during the pre-school years.

ATB, a partnership between A*Star Singapore Institute for Clinical Sciences, the Centre for Holistic Initiatives for Learning and Development (Child), and PCF Sparkletots, is an example of how research is being translated into practice to benefit children.

At the launch of the inaugural Child Conference on Thursday, Minister for Social and Family Development and Second Minister of Health Masagos Zulkifli said the research and efforts in child health and development come amid a shift in focus towards preventive care, among other things.

"Instead of waiting for problems to arise, we step in early... Intervening when there are early signals, warning signs, before they snowball into bigger problems later," he said.

"To do so, we need to be informed by research so that we can plan our interventions towards effective outcomes."

When it comes to supporting children and their families, efforts cut across health and social domains, while programmes are designed to support families, and not just the individual, said Mr Masagos.

At a fireside chat during the conference on Thursday, Senior Parliamentary Secretary for Health Rahayu Mahzam said research such as the Gusto findings on how portion size and speed of

The Appetite Toolbox programme is being carried out at six childcare centres. It involves 205 children aged between three and six, and their caregivers. PHOTO: A*STAR SINGAPORE INSTITUTE FOR CLINICAL SCIENCES

Kids' early years a critical window for development

FROM A20

eating can impact obesity can be turned into bite-sized information to help parents teach their children healthy eating habits.

Apart from the knowledge, collaboration is key, she said.

"To truly have collaboration, we need to... look holistically, understand the ecosystem, who are the players in the ecosystem, what is available, what is the true gap, and what is the true value that we can bring into that space," she added.

At the same fireside chat, Minister of State for Home Affairs and Social and Family Development Sun Xueling said families spend a lot on tuition when their children go to primary school, but the early years of life are actually a critical window of development.

She highlighted the research from Gusto that showed that infants who watch more than two hours of television a day have lower-than-average IQs, and said emphasis should be placed on pre-school learning.

"It's about how we're encouraging our children to learn – outdoor play, being creative, having more free time of their own... learning through interacting with other children. It's not about... learning multiplication tables in the early years," said Ms Sun.

Child, a multi-agency effort set up in 2021, brings together experts from across a range of disciplines, including health, education, sociology, psychology, artificial intelligence and data analytics, to put the findings in the Gusto study into practice.

Its inaugural biennial conference, held at the Grand Copthorne Waterfront Hotel, is a platform for early childhood stakeholders to discuss challenges and solutions.

Professor Adrian Sandler, executive director of Child, which is based at NUS Yong Loo Lin School of Medicine, said on Thursday: "We aim to speak for the science of child development, to accelerate the translation of research into policy and practice and to improve outcomes especially for the disadvantaged."

The conference ends on Friday.

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In Summary

- The data collected by GUSTO **highlight gaps and opportunities** for us to improve on the **health and human potential** of Singaporeans, at key points across the life course.
- **Opportunities** identified for optimizing early child development:
  1. **Maternal** emotional health
     - Preconception
     - Antenatal
     - Postnatal
  2. **Early childhood** environment
     - Early screening
     - Screen time
     - Early eating behaviours

**If you mess up your children,
nothing else you do really matters.**

Jacqueline Kennedy Onassis
1929-1994