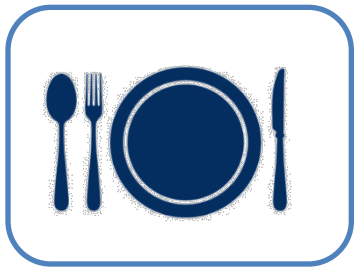
Diet in Pregnancy in relation to subsequent Maternal and Neonatal Health

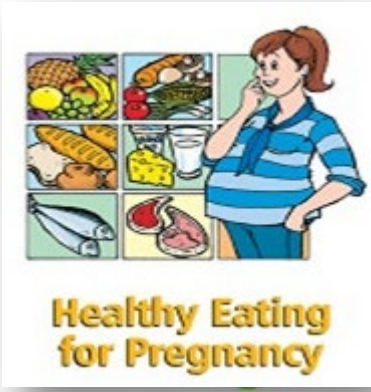
Prof Fionnuala McAuliffe
University College Dublin
National Maternity Hospital Ireland

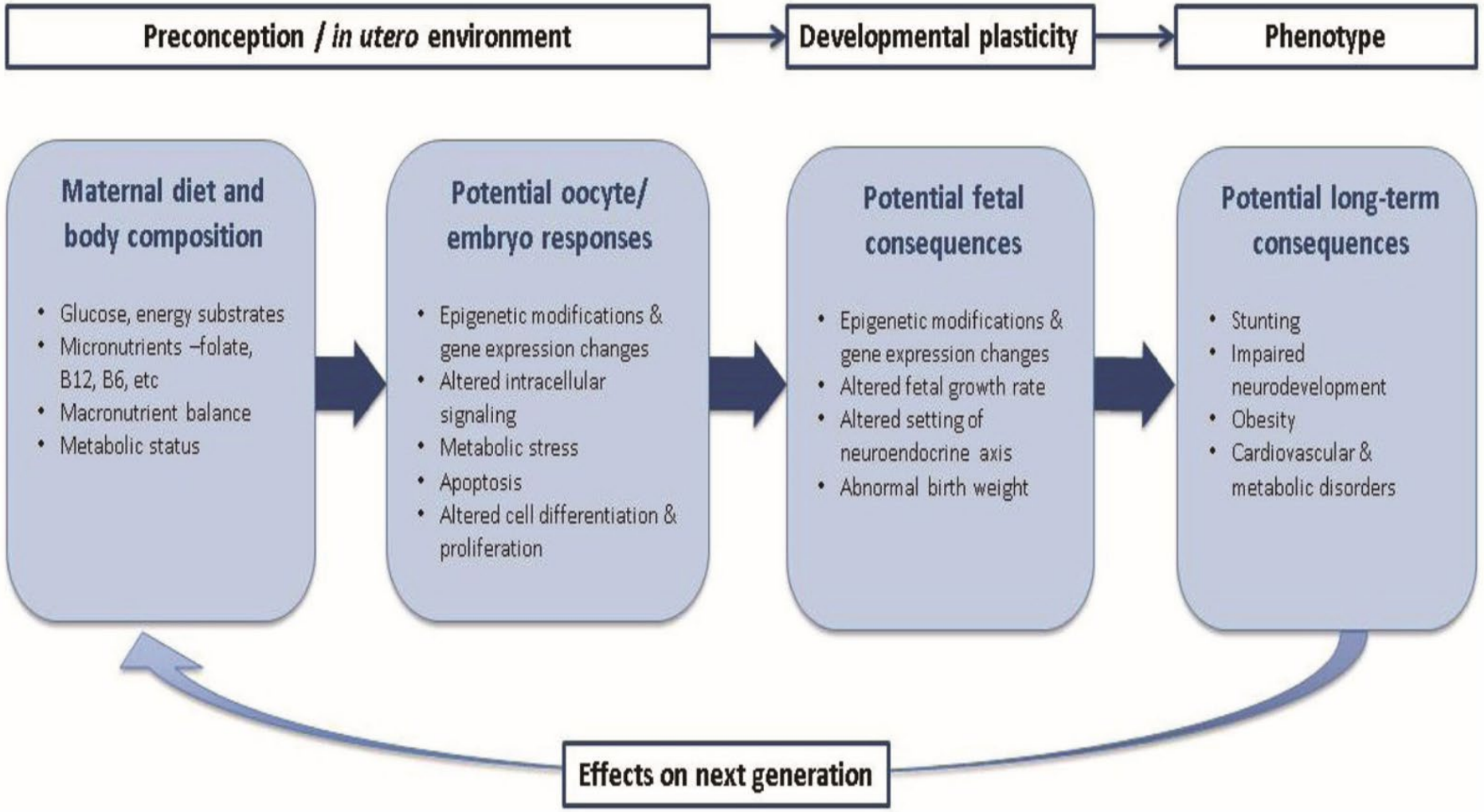
EGEA Lyon Nov 8th 2018

Nutrition in Pregnancy

- Nutritional requirements increase
- Opportunity to improve health
  - Motivated ‘a teachable moment’ (O’Brien O.A. *et al.*, 2017)
  - Regular contact with HCPs (Jackson *et al*., 2011)
- Lifelong value for offspring (Barker, 1997)
- Nutrition impacts on maternal outcomes
  - Gestational weight gain (Walsh *et al*., 2012)
  - Delivery and caesarean section (i-WIP Collaborative Group, 2017
  - Blood glucose concentrations (Zhang *et al*., 2016)







Hanson et al FIGO nutrition committee IJOG 2016

Figure 1: Obesity among adults, 2015 or nearest year

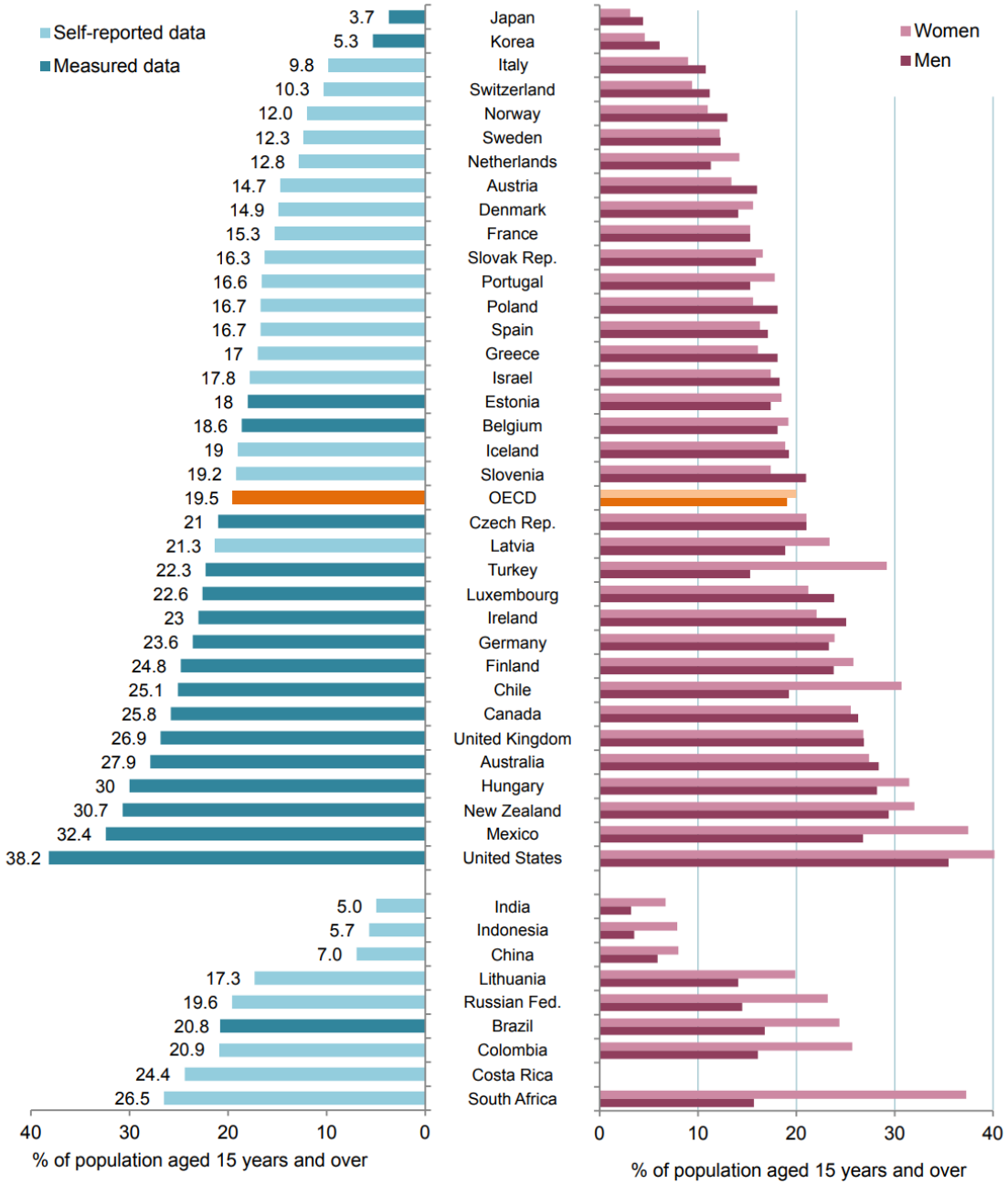
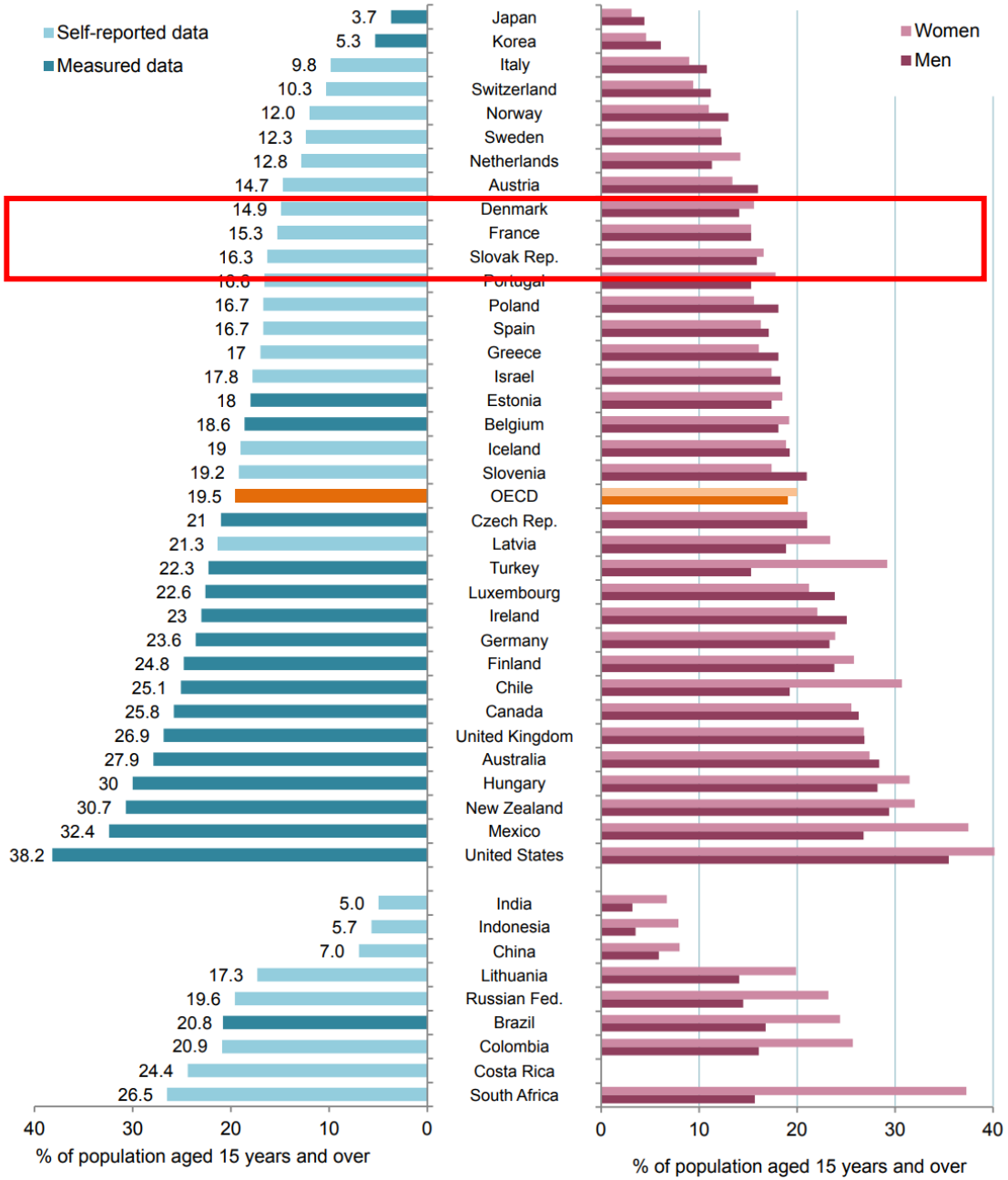
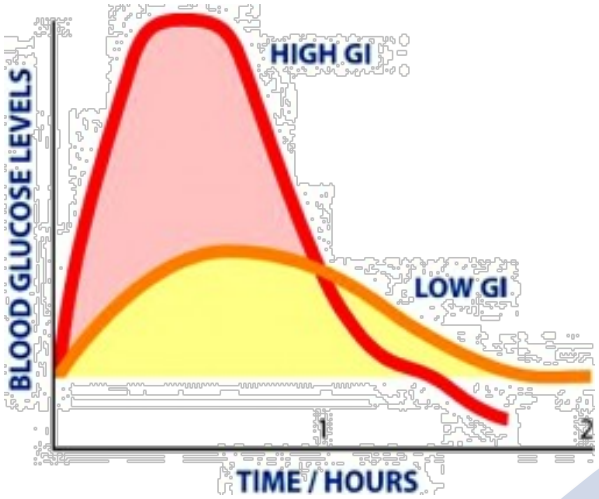


Figure 1: Obesity among adults, 2015 or nearest year



The westernised diet rich in carbohydrates is thought to contribute to the rates of obesity

Not all carbohydrate foods are created equal



High GI

Medium GI

Low GI

- Pregnancy is a condition in which the glycaemic index may be of particular relevance

- Maternal glucose is the main energy substrate for intrauterine growth

RCT Of LOw glycaemic index diet vs usual diet to prevent macrosomia

BMJ

BMJ 2012;345:e5605 doi: 10.1136/bmj.e5605 (Published 30 August 2012)

RESEARCH

Low glycaemic index diet in pregnancy to prevent macrosomia (ROLO study): randomised control trial

OPEN ACCESS

Jennifer M Walsh *clinical research fellow, specialist registrar in obstetrics and gynaecology*, Ciara A McGowan *research dietician*, Rhona Mahony *consultant obstetrician and gynaecologist*, Michael E Foley *consultant obstetrician and gynaecologist*, Fionnuala M McAuliffe *professor of obstetrics and gynaecology*

UCD Obstetrics and Gynaecology, School of Medicine and Medical Science, University College Dublin, National Maternity Hospital, Dublin, Ireland.

Walsh, McGowan, McAuliffe et al BMJ 2012

ROLO

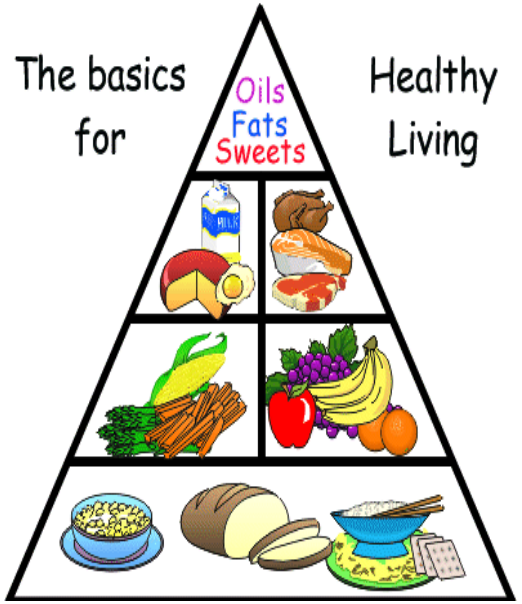
- **P**: Secundigravid with previous birthweight >4000g (n=759)
- **I**: Healthy low GI diet from early pregnancy
- **C**: Routine care
- **O**: Birthweight
- Gestational weight gain, glucose intolerance, gestational diabetes

- **Excluded previous gestational diabetes**

Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012

ROLO-Intervention

- Focused on the Glycemic Index
- Exchange high GI carbohydrates for low GI alternatives
- Recipes
- Small groups of 2 – 6 people
- Gestation 15.7+/-3.0 weeks



Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012

ROLO main findings

- Low GI diet in pregnancy
- No difference in birthweight
  - Less infant adiposity (thigh circumference)

- Maternal benefits
  i. Less gestational weight gain of 1.3Kg
  ii. Improved glucose homeostasis
  iii. Improved nutrient and food intakes

Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012

Results – Glycaemic Load

	Intervention Group Low GI diet	Control Group
Early pregnancy	132± 33	136± 38
Second trimester	124± 32	140± 32*
Third trimester	127 ± 30	140 ± 37 *

Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012

Maternal Nutrient Intakes

	Trimester 1		Trimester 2		Trimester 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Energy (MJ)						
Protein (%TE)						
CHO (% TE)						
Fibre (g)						

P value – independent samples t test

Maternal Nutrient Intakes

	Trimester 1		Trimester 2		Trimester 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Energy (MJ)	7.7	7.8	7.6	8.1**	7.6	8.1*
Protein (%TE)	17.2	16.8	17.8	16.8***	17.6	16.7**
CHO (% TE)	50.3	50.3	49.0	50.0	49.1	50.1
Fibre (g)	19.9	18.9	20.2	19.2	20.3	18.8**

P value – independent samples t test

Maternal Nutrient Intakes

	Trimester 1		Trimester 2		Trimester 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Energy	7.7	7.8	**7.6**	**8.1****	**7.6**	**8.1***
Protein (%TE)	17.2	16.8	17.8	16.8***	17.6	16.7**
CHO (% TE)	50.3	50.3	49.0	50.0	49.1	50.1
Fibre (g)	19.9	18.9	20.2	19.2	20.3	18.8**

P value – independent samples t test

Maternal Nutrient Intakes

	Trimester 1		Trimester 2		Trimester 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Energy (MJ)	7.7	7.8	7.6	8.1**	7.6	8.1*
Protein	17.2	16.8	**17.8**	**16.8*** **	**17.6**	**16.7****
CHO (% TE)	50.3	50.3	49.0	50.0	49.1	50.1
Fibre (g)	19.9	18.9	20.2	19.2	20.3	18.8**

P value – independent samples t test

Maternal Nutrient Intakes

	Trimester 1		Trimester 2		Trimester 3	
	Int	**Control**	**Int**	**Control**	**Int**	**Control**
Energy (MJ)	7.7	7.8	7.6	8.1**	7.6	8.1*
Protein (%TE)	17.2	16.8	17.8	16.8***	17.6	16.7**
CHO (% TE)	50.3	50.3	49.0	50.0	49.1	50.1
Fibre (g)	19.9	18.9	**20.2**	**19.2**	**20.3**	**18.8****

P value – independent samples t test

Other Dietary Changes

- **Fruit** consumption was significantly higher at T3 among the intervention group (91% vs. 85%; $p<0.05$)
- **Vegetable** consumption was significantly higher at T3 among the intervention group (98% vs. 94%; $p<0.05$)
- **Oily fish** consumption was significantly higher at T2 among the intervention group (21% vs. 13%; $p<0.05$)

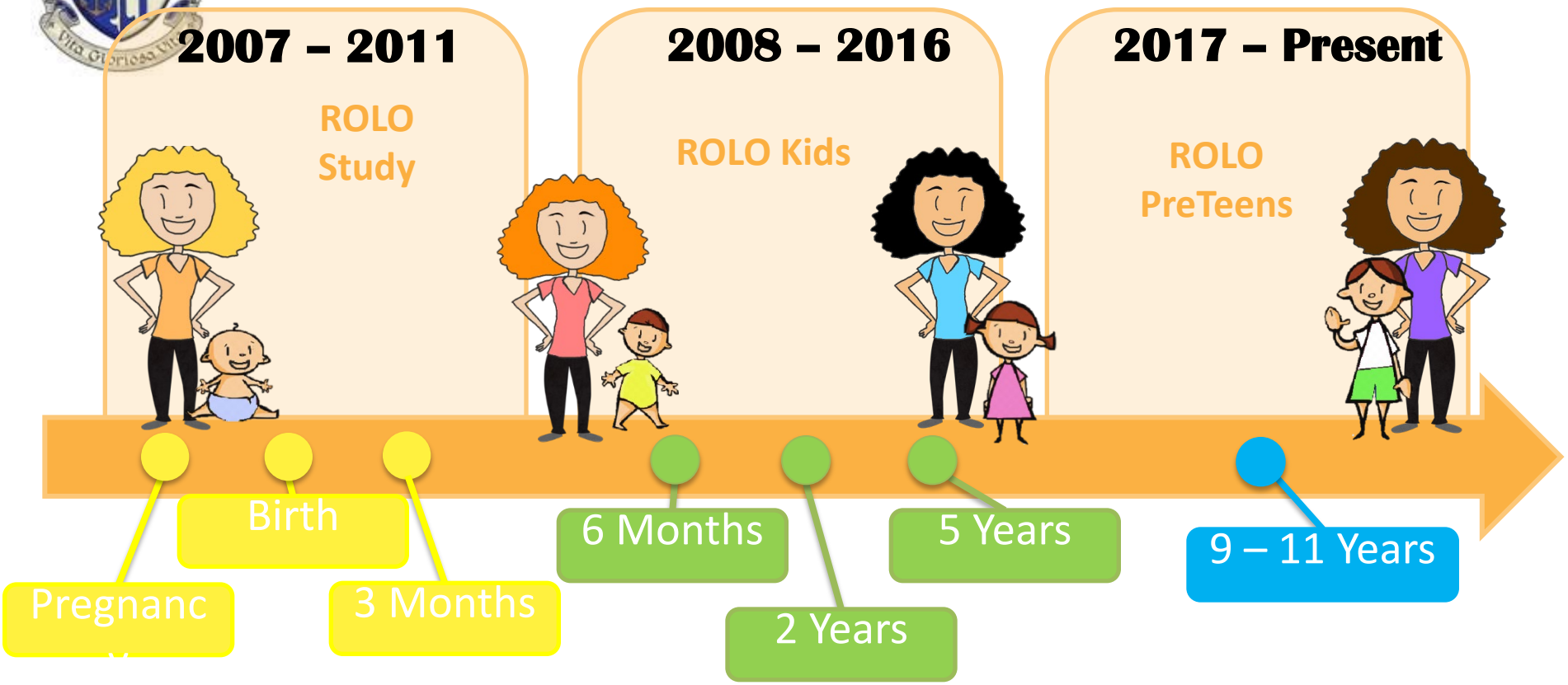
McGowan, McAuliffe 2013

Conclusion

- A low glycemic index diet in pregnancy has no effect on infant birthweight in a group at risk of fetal macrosomia

- Maternal benefits
  - Less gestational weight gain
  - Improved glucose homeostasis
  - Improved nutrient and food intakes

ROLO Study –Irish Birth Cohort



ROLO Study –Irish Birth Cohort

2007 – 2011

ROLO Study

Pregnancy – 3 Months

- Maternal anthropometry
- Food Diaries in each trimester
- Lifestyle information
- Fetal ultrasound measurements
- Maternal blood & urine samples
- Cord blood samples
- Infant anthropometry

2008 – 2016

ROLO Kids

6 months – 5 Years

- Maternal & child anthropometry
- Feeding & development
- FFQ
- Physical activity
- Blood Pressure
- Step test (child)
- Blood sample
- Body composition (BIA)
- Bone mineral density (DXA)

2017 – Present

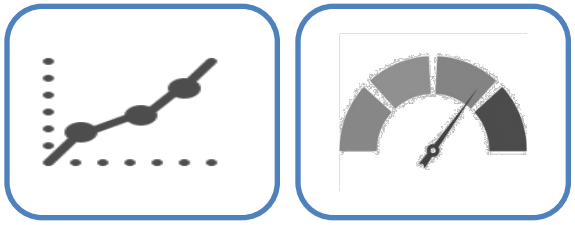
ROLO PreTeens

9 – 11 Years

- Maternal & child anthropometry
- FFQ
- Eating Behaviours
- Lifestyle information
- Physical activity and fitness
- Blood Pressure
- Blood and saliva samples
- Shuttle run (child)
- Bone mineral density (DXA)

Pregnancy - Window to Future Health

- Pregnancy itself as a determinant of future health
- Physiological demands of pregnancy have lasting effect on a woman's future health
  - Glucose tolerance
  - Gestational weight gain → weight retention
- Influence of diet or environmental factors
- Longitudinal studies lacking



HbA1c (mmol/mol) - 5-Year Follow-Up

	B	P	95% CI	Model P
Parity ≥3 children				
Fasting glucose, Early pregnancy, (mmol/L)				
Glucose intolerant, 28 weeks' gestation				

O'Brien, McAuliffe BJOG 2018

HbA1c (mmol/mol) - 5-Year Follow-Up

	B	P	95% CI	Model P
Parity ≥3 children	1.04	0.033	(0.09, 1.99)	0.035
Fasting glucose, Early pregnancy, (mmol/L)	1.70	0.013	(0.36, 3.04)	0.020
Glucose intolerant, 28 weeks' gestation	1.06	0.050	(0.00, 2.12)	0.039

O'Brien, McAuliffe BJOG 2018

Weight Retention (kg) - 5-Year Follow-Up

	B (%Δ)	P	95% CI	Model P
Well-being percentage score, change pregnancy to 5-year follow-up				
Gestational weight gain, (kg)				
Glycaemic Index, 5-year follow-up				
Glycaemic Load, 5-year follow-up				

O'Brien, McAuliffe BJOG 2018

Weight Retention (kg) - 5-Year Follow-Up

	B (%Δ)	P	95% CI	Model P
Well-being percentage score, change pregnancy to 5-year follow-up	-0.06	0.011	(-0.11, -0.02)	0.002
Gestational weight gain, (kg)	0.19	0.049	(0.00, 0.38)	0.001
Glycaemic Index, 5-year follow-up	0.26	0.012	(0.06, 0.46)	0.002
Glycaemic Load, 5-year follow-up	0.04	0.017	(0.01, 0.07)	0.002

O'Brien, McAuliffe BJOG 2018

Clinical Implications

Pregnancy

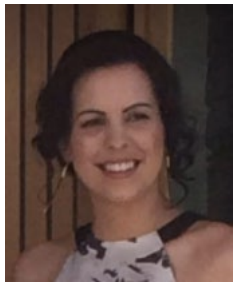
Pregnancy factors are determinants of future health

- Highlights pregnancy as opportunity to intervene
- Weight gain
- Glycaemic control – fasting early pregnancy

Postpartum

Weight retention postpartum

- Diet
  - Low GI: wholegrains, limit refined carbohydrate foods
  - Protein sources
- Well-being



2 year Infant Results

ORIGINAL ARTICLE

The association between maternal nutrition and lifestyle during pregnancy and 2-year-old offspring adiposity: analysis from the ROLO study

Mary K. Horan[1] · Jean M. Donnelly[1] · Ciara A. McGowan[1] · Eileen R. Gibney[2] · Fionnuala M. McAuliffe[1]

Horan et al, 2016 *Journal of Public Health*

2 Year Infant Results

	B	SEB	p	R^2adj	F	P
Weight-for-age z-score						
Mother MUA circumference baseline (cm)	0.065	0.035	0.065			
Trimester 3 saturated fat (%TE)	0.048	0.024	0.046	0.205	5.316	<0.001
2 year mother weight (kg)	0.030	0.014	0.035			
2 year mother BMI (kg/m^2)	-1110.7	421.127	0.009			
Age given drinks other than breastmilk (weeks)	-0.010	0.005	0.057			
Waist:length ratio						
Baseline maternal minutes sitting per weekday	4.71E-05	0.000	0.019			
Mother height (cm)	0.000	0.000	0.054	0.142	3.807	<0.001
Trimester 2 Polyunsaturated fat (%TE)	-0.005	0.002	0.017			
Trimester 3 Polyunsaturated fat (%TE)	-0.004	0.002	0.070			
Subscapular:triceps skinfold thickness ratio						
Trimester 1 Glycaemic Index	0.009	0.004	0.029	0.088	2.782	0.007
Trimester 2 Saturated Fat (%TE)	0.018	0.005	0.001			

*Controlled for maternal BMI, birthweight, education, gender, breastfeeding group

Horan et al, 2016 *Journal of Public Health*

2 Year Infant Results

	B	SEB	p	R^2adj	F	P
Weight-for-age z-score						
Mother MUA circumference baseline (cm)	0.065	0.035	0.065			
Trimester 3 saturated fat (%TE)	0.048	0.024	0.046	0.205	5.316	<0.001
2 year mother weight (kg)	0.030	0.014	0.035			
2 year mother BMI (kg/m^2)	-1110.7	421.127	0.009			
Age given drinks other than breastmilk (weeks)	-0.010	0.005	0.057			
Waist:length ratio						
Baseline maternal minutes sitting per weekday	4.71E-05	0.000	0.019			
Mother height (cm)	0.000	0.000	0.054	0.142	3.807	<0.001
Trimester 2 Polyunsaturated fat (%TE)	-0.005	0.002	0.017			
Trimester 3 Polyunsaturated fat (%TE)	-0.004	0.002	0.070			
Subscapular:triceps skinfold thickness ratio						
Trimester 1 Glycaemic Index	0.009	0.004	0.029	0.088	2.782	0.007
Trimester 2 Saturated Fat (%TE)	0.018	0.005	0.001			

*Controlled for maternal BMI, birthweight, education, gender, breastfeeding group

Horan et al, 2016 *Journal of Public Health*

2 Year Infant Results

	B	SEB	p	R^2adj	F	P
Weight-for-age z-score						
Mother MUA circumference baseline (cm)	0.065	0.035	0.065			
Trimester 3 saturated fat (%TE)	0.048	0.024	0.046	0.205	5.316	<0.001
2 year mother weight (kg)	0.030	0.014	0.035			
2 year mother BMI (kg/m^2)	-1110.7	421.127	0.009			
Age given drinks other than breastmilk (weeks)	-0.010	0.005	0.057			
Waist:length ratio						
Baseline maternal minutes sitting per weekday	4.71E-05	0.000	0.019			
Mother height (cm)	0.000	0.000	0.054	0.142	3.807	<0.001
Trimester 2 Polyunsaturated fat (%TE)	-0.005	0.002	0.017			
Trimester 3 Polyunsaturated fat (%TE)	-0.004	0.002	0.070			
Subscapular:triceps skinfold thickness ratio						
Trimester 1 Glycaemic Index	0.009	0.004	0.029	0.088	2.782	0.007
Trimester 2 Saturated Fat (%TE)	0.018	0.005	0.001			

*Controlled for maternal BMI, birthweight, education, gender, breastfeeding group

Horan et al, 2016 *Journal of Public Health*

2 Year Infant Results

	B	SEB	p	R^2adj	F	P
Weight-for-age z-score						
Mother MUA circumference baseline (cm)	0.065	0.035	0.065			
Trimester 3 saturated fat (%TE)	0.048	0.024	0.046	0.205	5.316	<0.001
2 year mother weight (kg)	0.030	0.014	0.035			
2 year mother BMI (kg/m^2)	-1110.7	421.127	0.009			
Age given drinks other than breastmilk (weeks)	-0.010	0.005	0.057			
Waist:length ratio						
Baseline maternal minutes sitting per weekday	4.71E-05	0.000	0.019			
Mother height (cm)	0.000	0.000	0.054	0.142	3.807	<0.001
Trimester 2 Polyunsaturated fat (%TE)	-0.005	0.002	0.017			
Trimester 3 Polyunsaturated fat (%TE)	-0.004	0.002	0.070			
Subscapular:triceps skinfold thickness ratio						
Trimester 1 Glycaemic Index	0.009	0.004	0.029	0.088	2.782	0.007
Trimester 2 Saturated Fat (%TE)	0.018	0.005	0.001			

*Controlled for maternal BMI, birthweight, education, gender, breastfeeding group

Horan et al, 2016 *Journal of Public Health*

Maternal lipids and childhood adiposity

- Dietary saturated fat, mono and poly unsaturated fat intake associated with total cholesterol levels in early pregnancy (p=0.02)

Geraghty et al, 2016 *Plos One*

Blood Lipids and Birthweight

Model	*B*	*P*	r^2 adj	F	*P*
TG (late)	111.17	0.034			
TG (cord)	-453.75	0.013	0.318	6.54	<0.001
LDL-C (cord)	88.55	0.426			

*Controlled for mother's BMI, education level, smoking, gestational age, gender, leptin cord blood

Geraghty et al, 2016 *Plos One*

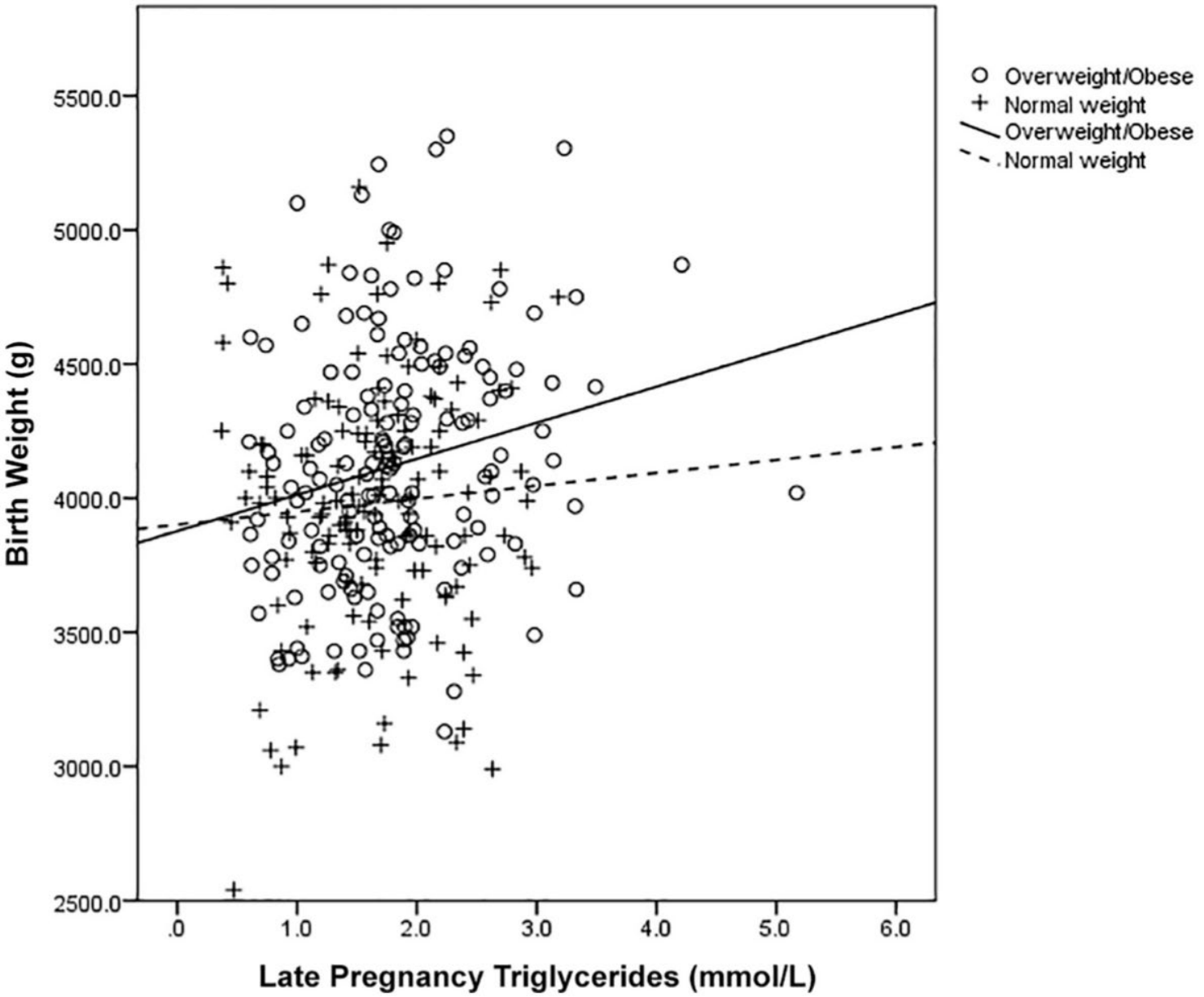


Fig 1. Scatter plot displaying the association between birth weight and late pregnancy triglyceride concentrations stratified by BMI category.

Dietary Protein in Pregnancy

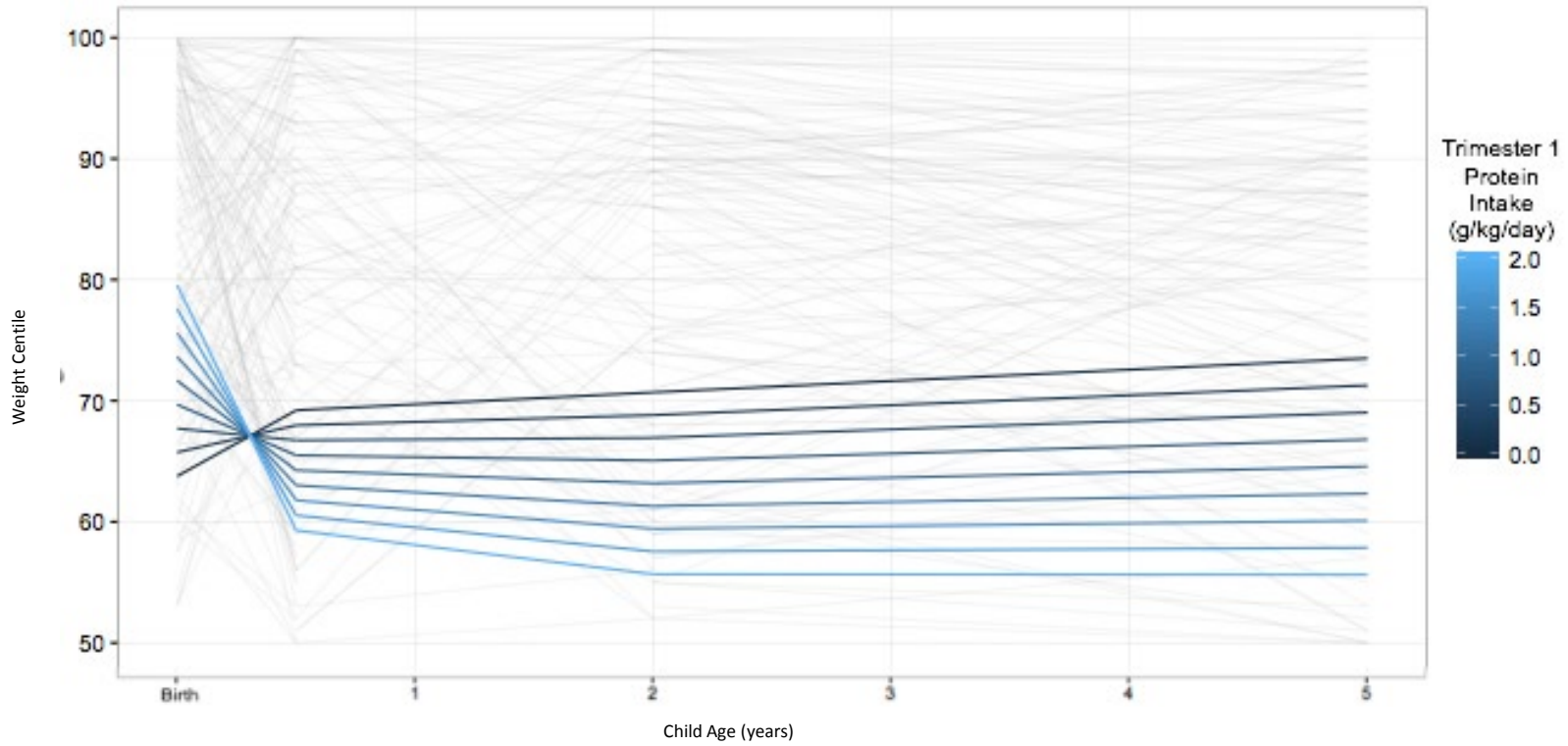
Geraghty, McAuliffe et al, BJN 2018

Dietary Protein in Pregnancy

- 570 ROLO mother and child dyads
- Food Diaries in each trimester
  - Protein intake per kg of maternal weight (gr/day/kg)
- Child body composition
  - Birth, 6 months, 5 Years
- Weight, BMI, Waist:length ratio, Skinfolds

Geraghty, McAuliffe et al, BJN 2018

Dietary Protein in Pregnancy



Geraghty, McAuliffe et al, BJN 2018

ROLO kids

- Diet in pregnancy associated with infant BMI and adiposity
  - Maternal Glycaemic index
  - Maternal Lipids
  - Maternal Protein intake

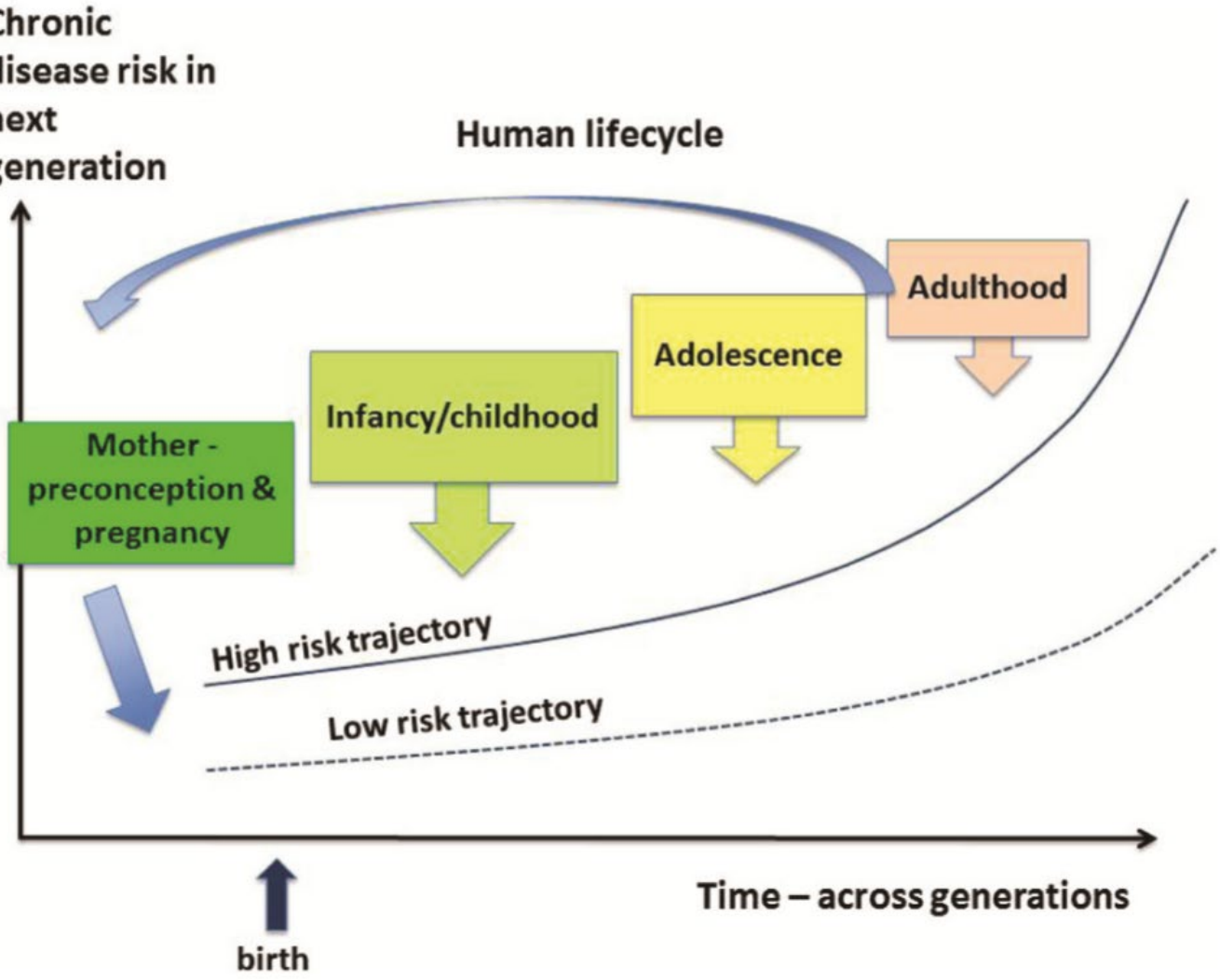


Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: meta-analysis of individual participant data from randomised trials

The International Weight Management in Pregnancy (i-WIP) Collaborative Group

- 36 RCT, N=12,526 women
- −0.70kg (95% CI −0.92 to−0.48kg) Gestational Weight Gain
- Lowed the odds of caesarean section by 0.91 (95% CI 0.83 to 0.99)

BMJ 2017



Lifecourse model of chronic disease

Developmental trajectories developed in early life influenced by maternal diet and body composition affect the risk of disease across the lifecourse

International Federation of Gynaecology and Obstetrics FIGO

- 2014 set up a maternal nutrition working committee
- Obstetricians/nutritionists/scientists
- Guidelines for nutrition from adolescence, pregnancy and postpregnancy

Contents lists available at ScienceDirect

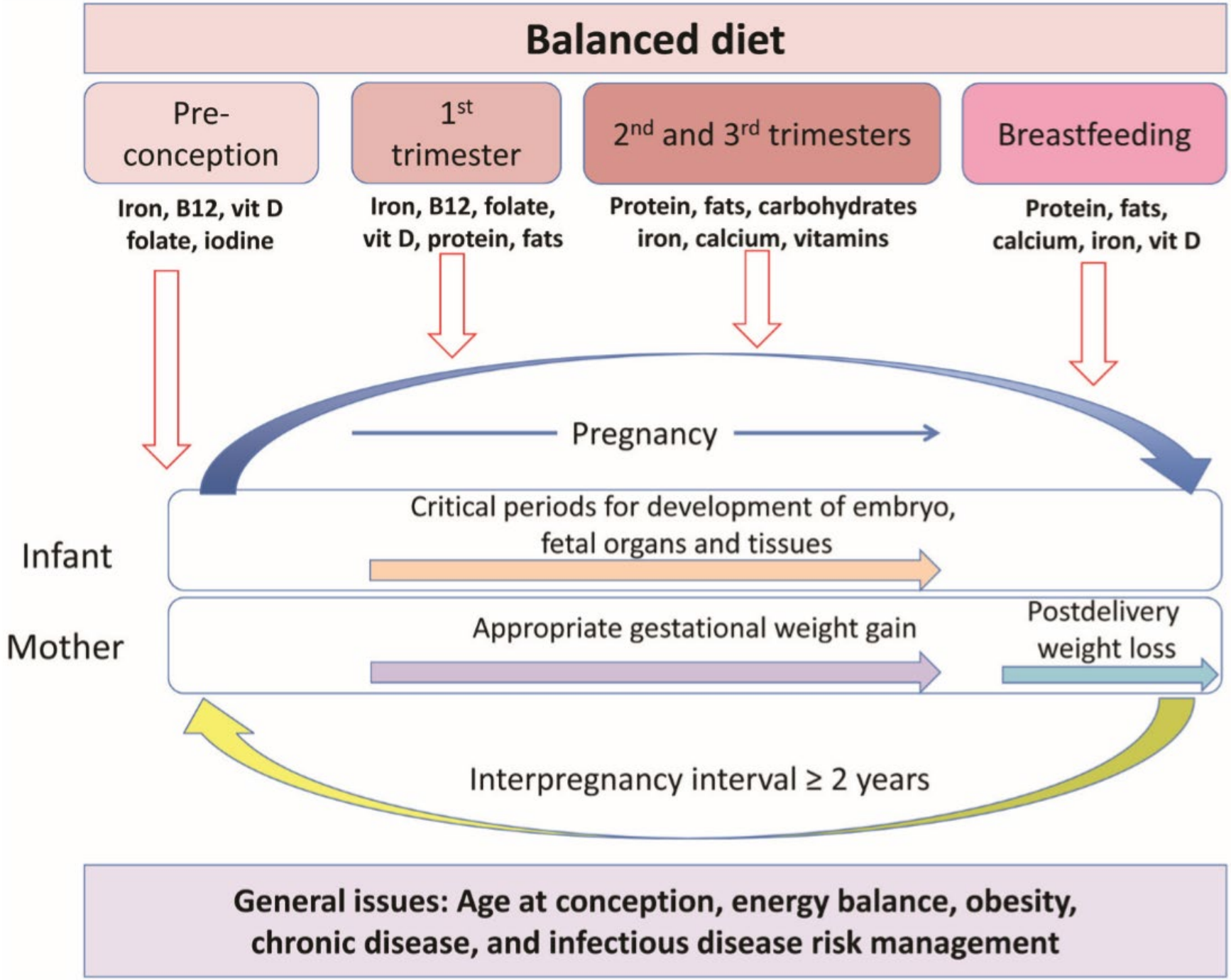
International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo

The International Federation of Gynecology and Obstetrics (FIGO) recommendations on adolescent, preconception, and maternal nutrition: "Think Nutrition First"#

Mark A. Hanson[a], Anne Bardsley[b], Luz Maria De-Regil[c], Sophie E. Moore[d], Emily Oken[e], Lucilla Poston[f], Ronald C. Ma[g], Fionnuala M. McAuliffe[h], Ken Maleta[i], Chittaranjan N. Purandare[j], Chittaranjan S. Yajnik[k], Hamid Rushwan[l], Jessica L. Morris[l,*]

2015


Balanced diet
Pre-conception
1st trimester
2nd and 3rd trimesters
Breastfeeding
Iron, B12, vit D folate, iodine
Iron, B12, folate, vit D, protein, fats
Protein, fats, carbohydrates iron, calcium, vitamins
Protein, fats, calcium, iron, vit D
Pregnancy
Infant
Critical periods for development of embryo, fetal organs and tissues
Mother
Appropriate gestational weight gain
Postdelivery weight loss
Interpregnancy interval ≥ 2 years
General issues: Age at conception, energy balance, obesity, chronic disease, and infectious disease risk management

FIGO Initiative on
Adolescent, Preconception and Maternal Nutrition

Good Nutrition Matters

UNDERNUTRITION
causes approximately
3.5 million
DEATHS
of women and children

OVERNUTRITION
is producing an increase in chronic NON-COMMUNICABLE DISEASES such as
DIABETES AND HYPERTENSION

MICRONUTRIENT DEFICIENCIES
affect **2** billion people worldwide and are caused by an
INADEQUATE DIET
which lacks VITAMINS AND MINERALS

Think Nutrition First

Good nutrition → Good health
IMPROVING NUTRITION
and establishing healthy dietary habits in adolescent girls and in the preconceptional period of women paves the way for healthy pregnancies and healthy babies

Building a prosperous future today
A woman's **FITNESS AND HEALTH**
is the foundation for her future health and that of generations to come

Think of the children
BENEFITS
for the next generation include reduced risk of stunting, obesity, and chronic non-communicable diseases and improved cognitive and behavioral development

FIGO Recommends

Greater **ATTENTION** to the links between poor maternal nutrition and increased risk of later non-communicable diseases in the mother and offspring

Greater **ACCESS** to preconception services for women of reproductive age to assist with planning and preparation for healthy pregnancies and healthy children

ACTION
to improve nutrition among adolescent girls and women of reproductive age

Public health
MEASURES to improve nutritional education, particularly of adolescents, girls and young women

Increased
AWARENESS
of the impact of women's nutrition on themselves and on future generations

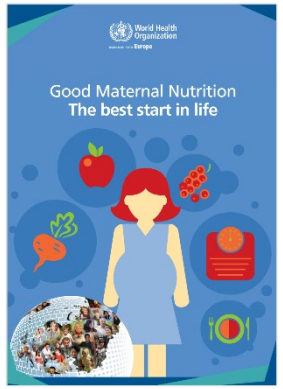
Taken from The International Federation of Gynecology and Obstetrics (FIGO) Recommendations on Adolescent, Preconception, and Maternal Nutrition: "Think Nutrition First." Int J Gynecol Obstet 2015;131(Suppl 4):S213-254.

The FIGO Initiative on Adolescent, Preconception and Maternal Nutrition (Phase 1) was supported by an unrestricted educational grant from Abbott

Infographic produced by the Micronutrient Initiative

Conclusions and Recommendations

- Maternal nutrition important and requires input from all Healthcare Professionals
- Maternal dietary interventions reduce excessive gestational weight gain & improve glucose homeostasis
- Maternal saturated fat and protein intake also important



Prof. Fionnuala McAuliffe, Director
Consultant & Head of Women & Children's Health

Prof. Colm O'Donnell
Neonatology

Prof. Mary Higgins,
Obstetrician

Cecily Mulcahy,
Research Midwife

Prof. Mary Wingfield,
Reproductive Medicine

Dr Aisling Geraghty,
Postdoc

Dr Eileen O'Brien,
Postdoc

David Byrne,
Research Assistant

Shauna Callaghan
Research Midwife

Siofra Maher,
MSc Student

Laurann O'Reilly,
Research Assistant

Dr. Rebecca Moo
MD student

Dr. Maria Kennelly, *PhD*

Stephanie Begley
Administrative Manager

UCD Perinatal Research Centre

HRB Health Research Board

SEVENTH FRAMEWORK PROGRAMME

EARLYNUTRITION
Long-term effects of early nutrition on later health

sfi Science Foundation Ireland

UCD DUBLIN