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Medical and surgical approaches to the management of obesity

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“The determinants of a successful pregnancy”

ESHRE Campus symposium

Dubrovnik, Croatia

24-25 September 2010



European Society of
Human Reproduction and Embryology



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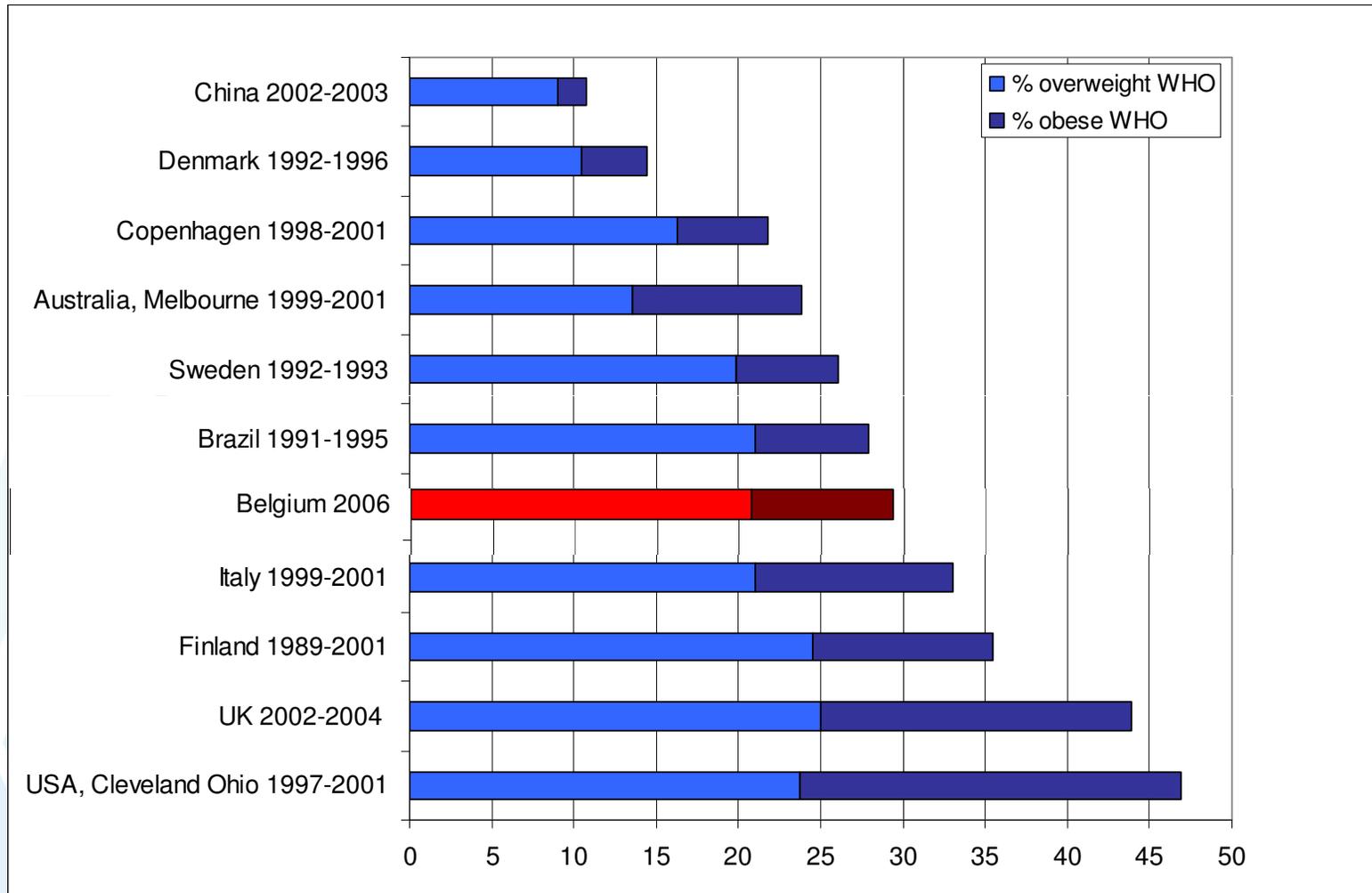
Overview

- Epidemiology of obesity and treatment options
- Indications for bariatric surgery
- Effects on fertility
- Effects on pregnancy
- Recommendations for clinical care

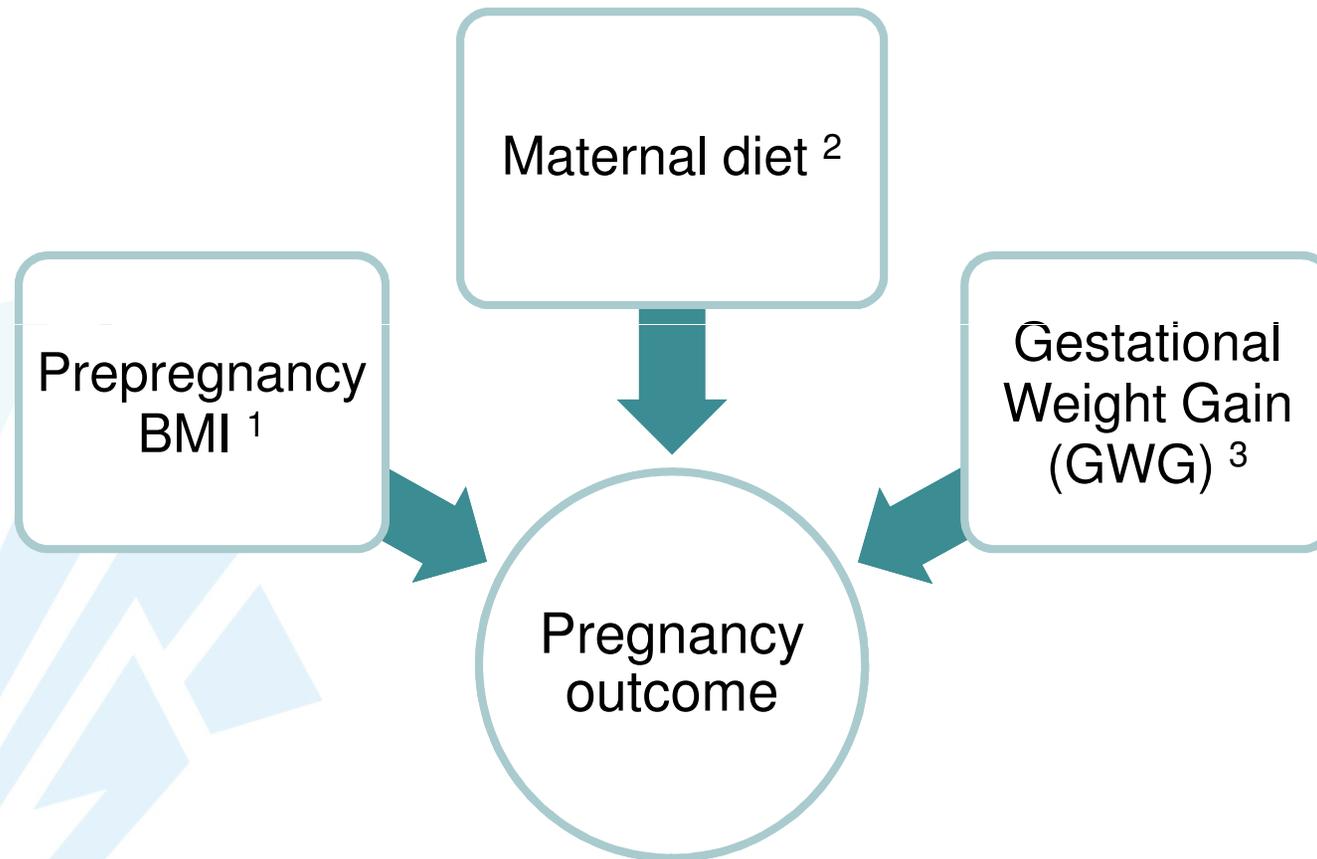


"Venus in front of the mirror"
PP Rubens, 1613

Prevalence of overweight and obese women in pregnancy



Pregnancy and obesity

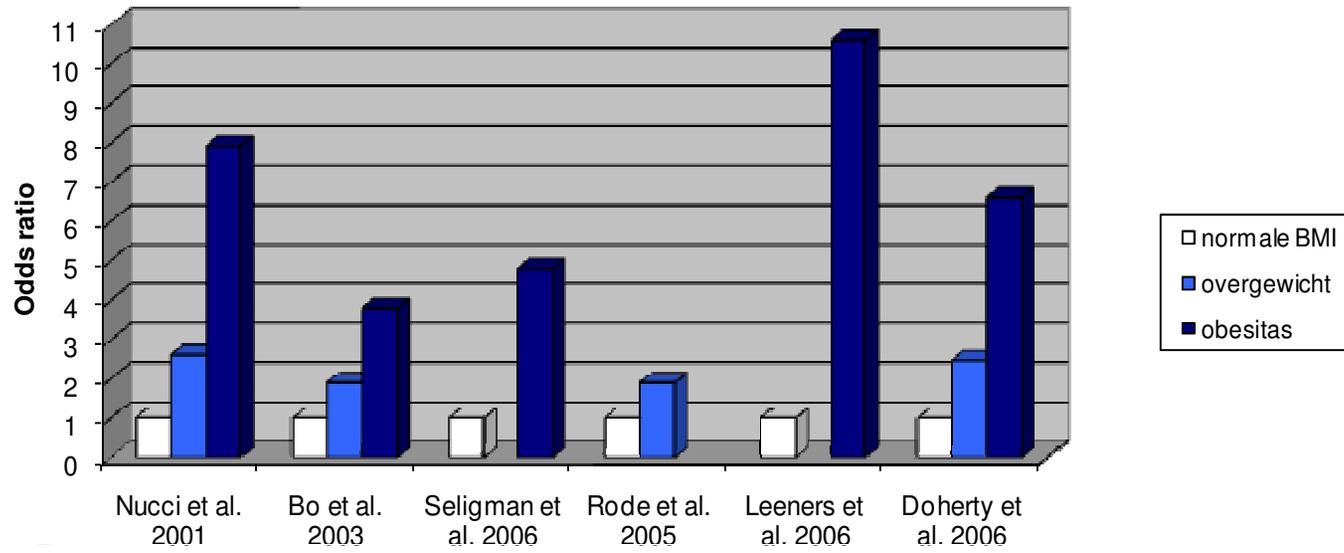


¹ Villamor et al. Lancet 2006; ² Kaiser L et al al. J Am Diet Assoc 2008; ³ Viswanathan et al. Evid Rep Technol Assess 2008

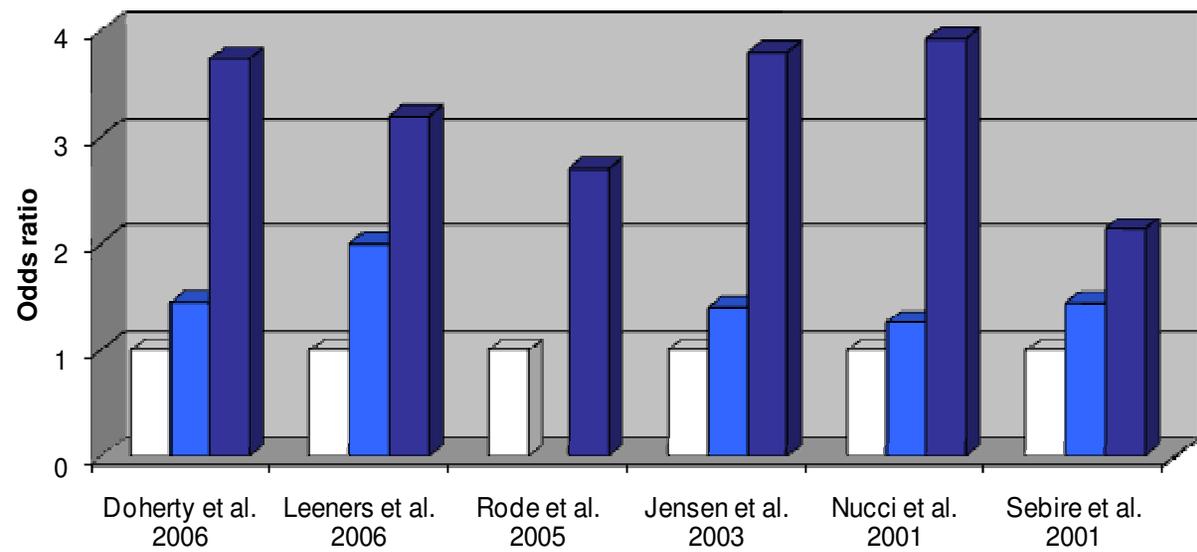
Complications of obesity in pregnancy



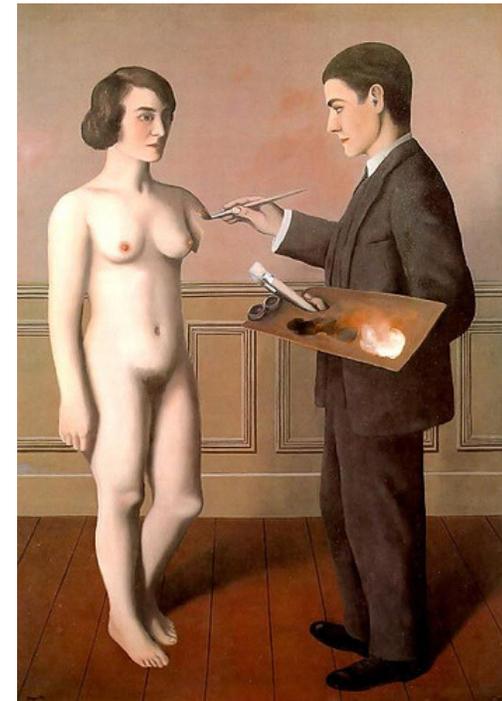
Hypertension



Pre-eclampsia



Treatment of obesity during pregnancy



R Magritte "attempting the impossible"

Treatment of Obesity during pregnancy?

- Reduced in pregnancy
- Some PA contra-indicated

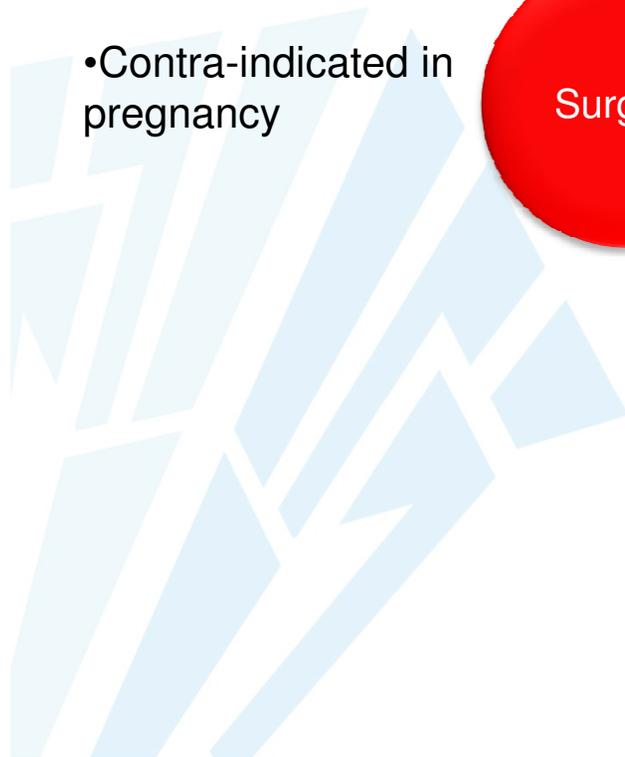


- No registered safe products



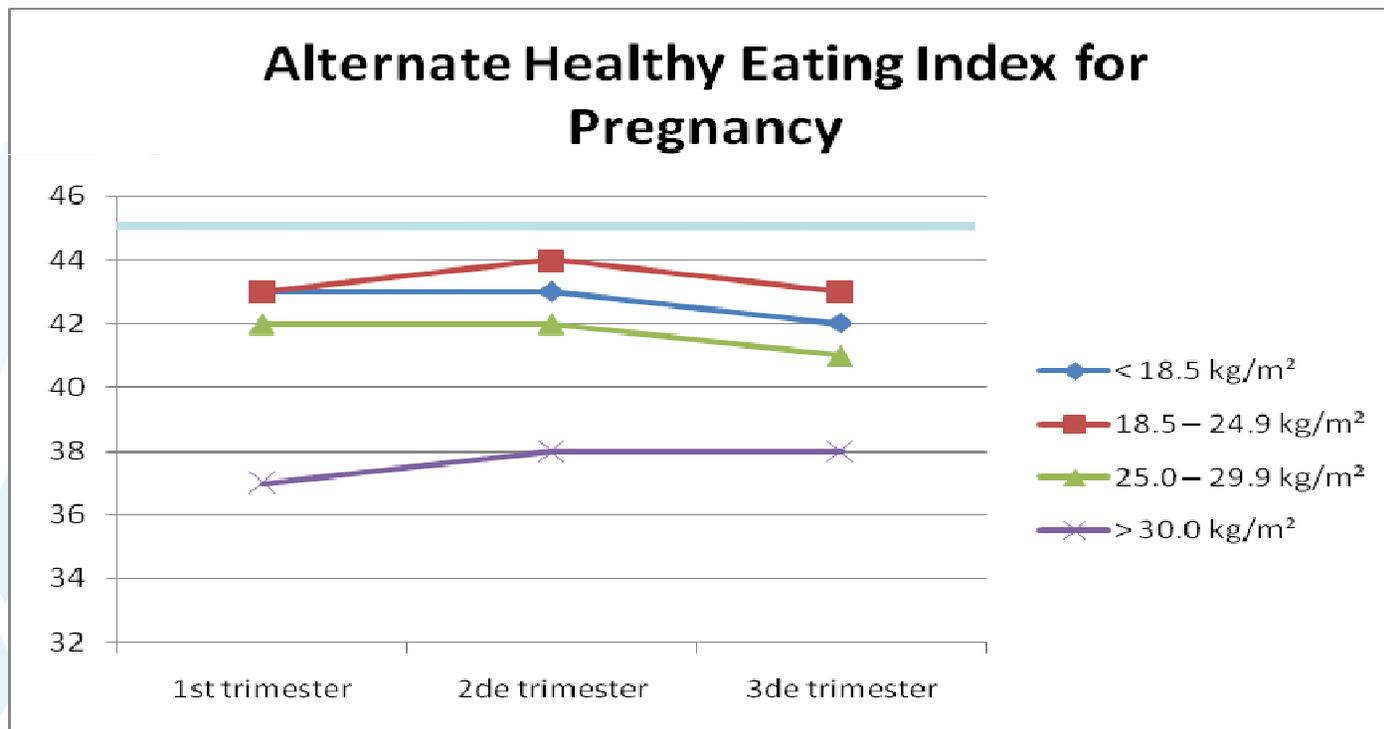
- Poor diet, especially in the obese
- Intervention studies show benefit
- No effect on pregnancy outcome

- Contra-indicated in pregnancy



Diet quality in obese pregnant women

- Prospective longitudinal study, N = 142
- 4 BMI categories
- Evaluation of diet quality during each trimester



Life style coaching

The screenshot shows a web browser window with the URL 'Voeding tijdens zwangerschap | U...'. The page header includes the UZ Leuven logo, navigation links for 'Contact', 'Ligging', and 'Over UZ Leuven', a search bar with 'Zoeken ->', and a language selector for 'Nederlands'. A main navigation menu contains links for 'HOME', 'PATIËNTEN', 'BEZOEKERS', 'HUISARTSEN', 'ACTUEEL', 'PUBLICATIES', 'OPLEIDING', 'ONDERZOEK', and 'WERKEN IN UZ LEUVEN'. A breadcrumb trail indicates the current location: 'U bevindt zich hier : Home > Diensten > Voeding tijdens zwangerschap'. The page title is 'Voeding tijdens zwangerschap'. On the left, a sidebar menu lists various topics under 'Voeding tijdens zwangerschap', including 'Gezonde voeding', 'Gewichtstoename', 'Gewichtsverlies na de bevalling', 'Voedselveiligheid', 'Voedingssupplementen', 'Zwangerschapskwaaltjes', 'Zwanger na obesitaschirurgie', 'Veelgestelde vragen', 'Links', and 'Contact Voeding tijdens zwangerschap'. The main content area features a large image of fresh fruits (strawberries, apples, grapes) and a sub-header 'Gezond zwanger: voedings- en hygiëne-tips'. The text discusses the importance of a healthy lifestyle and diet during pregnancy, mentioning 'gezonde levensstijl', 'voedselveiligheid', 'voedingssupplementen', and 'gewichtstoename'. A right sidebar contains a 'Kalender' section with an entry for '04 02 Studiedag "Gewicht en zwangerschap: weegt het op?"' and a link for 'meer informatie +'. The footer contains copyright information: '© 2010 UZ Leuven | Netwerziekenhuizen | Contact | Algemeen telefoonnummer 016 33 22 11' and a small icon.

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U bevindt zich hier : Home > Diensten > Voeding tijdens zwangerschap

HOOG CONTRAST

Voeding tijdens zwangerschap

- Gezonde voeding
- Gewichtstoename
- Gewichtsverlies na de bevalling
- Voedselveiligheid
- Voedingssupplementen
- Zwangerschapskwaaltjes
- Zwanger na obesitaschirurgie
- Veelgestelde vragen
- Links
- Contact Voeding tijdens zwangerschap

Voeding tijdens zwangerschap



Gezond zwanger: voedings- en hygiëne-tips

Het hebben van een [gezonde levensstijl](#) met een gebalanceerde en gevarieerde voeding, voldoende fysieke activiteit en niet roken tijdens de zwangerschap is belangrijk voor zowel uw baby als u zelf. Naast een gezonde voeding, is aandacht voor enkele voedingsstoffen en [voedselveiligheid](#) ook aangewezen tijdens de zwangerschap. Om te voldoen aan de aanbevolen inname aan bepaalde voedingsstoffen raden wij u bepaalde [voedingssupplementen](#) aan tijdens de zwangerschap. Een gezonde levensstijl zal u tevens helpen om een aanbevolen [gewichtstoename](#) tijdens uw zwangerschap te verkrijgen en om de kans op [zwangerschapskwaaltjes](#) te verminderen.

Heeft u vragen omtrent uw levensstijl tijdens de zwangerschap, dan kan u kijken onder de rubriek "[veelgestelde vragen](#)" of ons [contacteren](#).

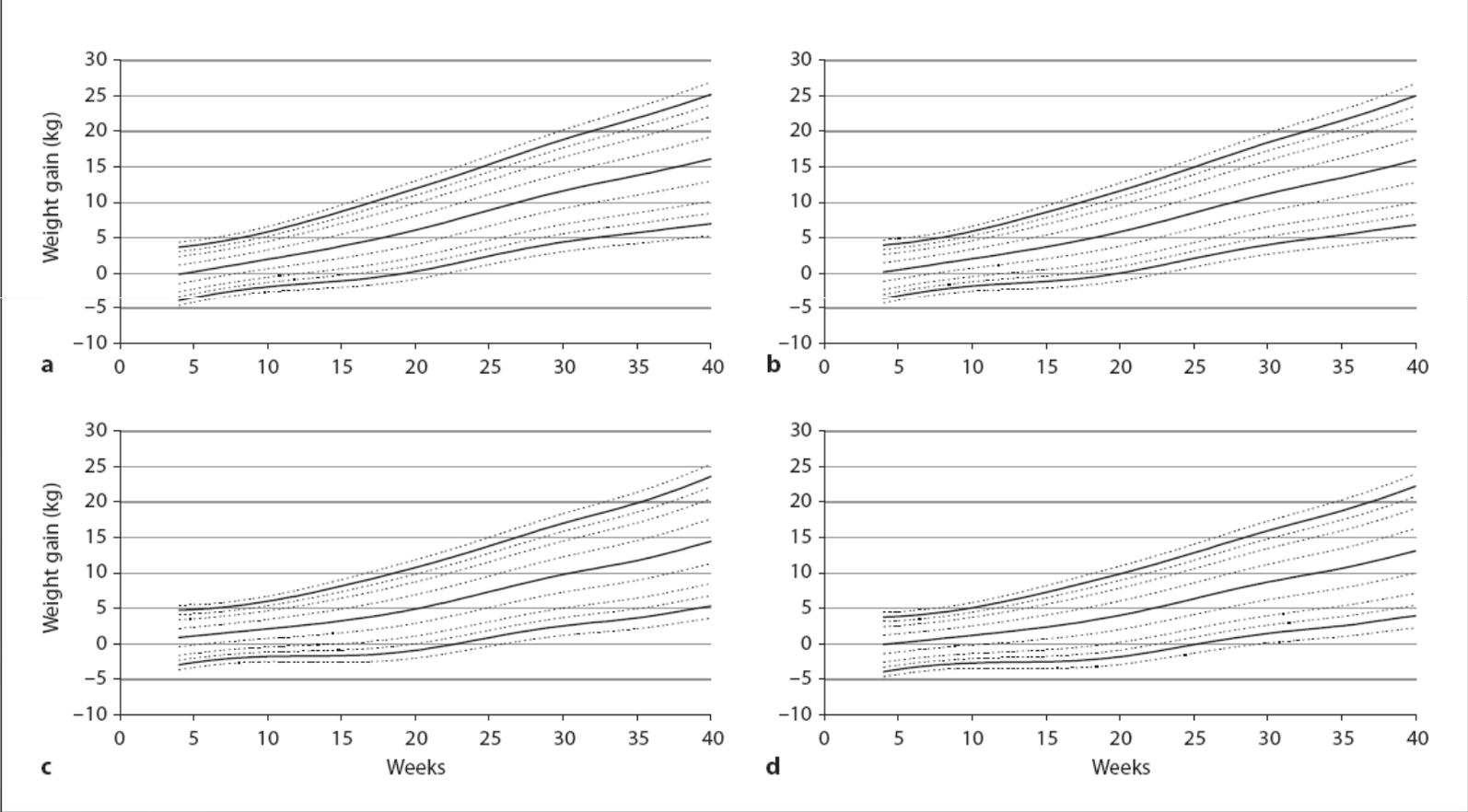
Kalender

04 02 Studiedag "Gewicht en zwangerschap: weegt het op?"

[meer informatie +](#)

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Percentile curves for GWG for each BMI category



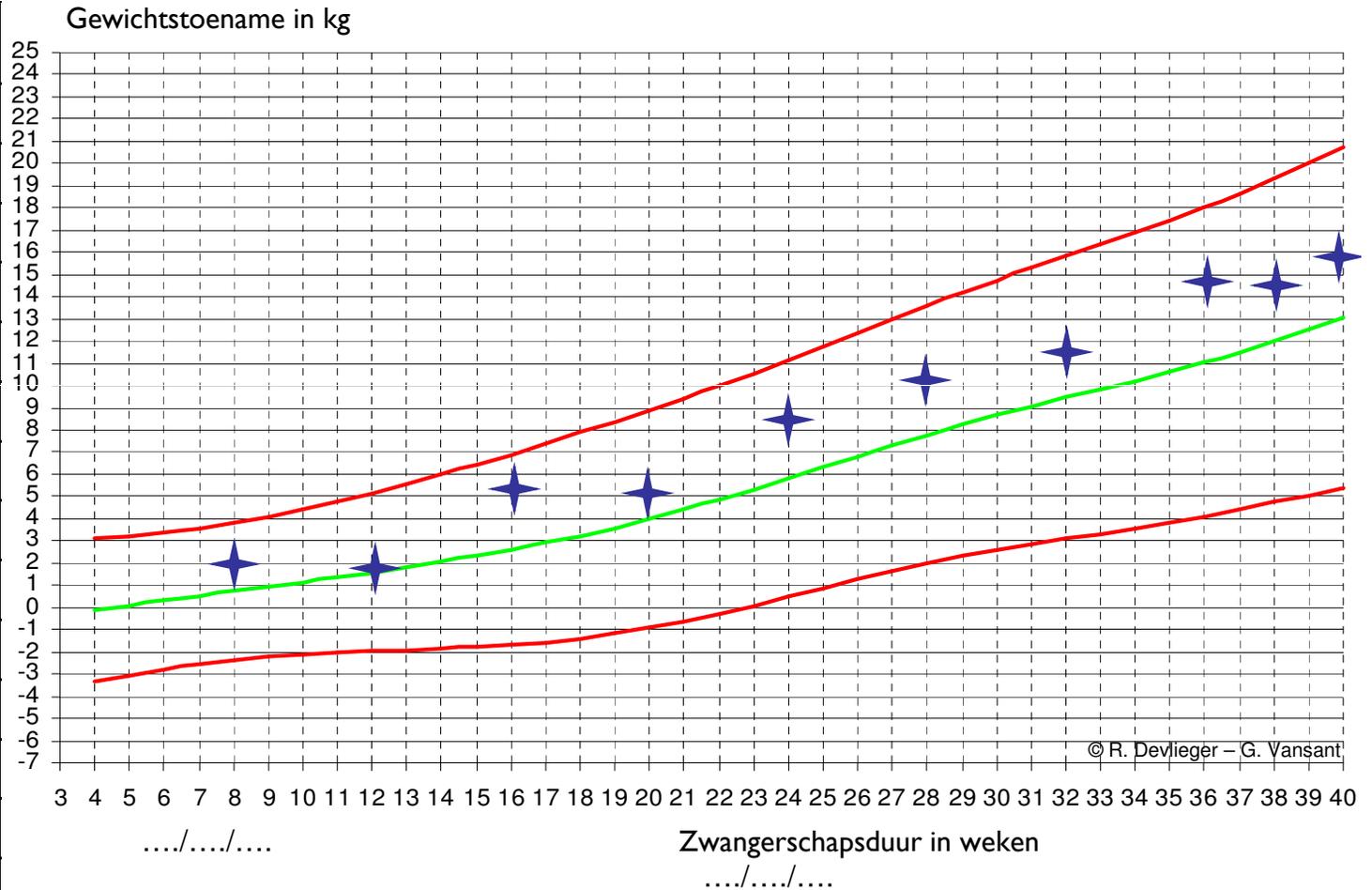


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Ideale gewichtstoename tijdens de zwangerschap

BMI > 29,0 kg/m²

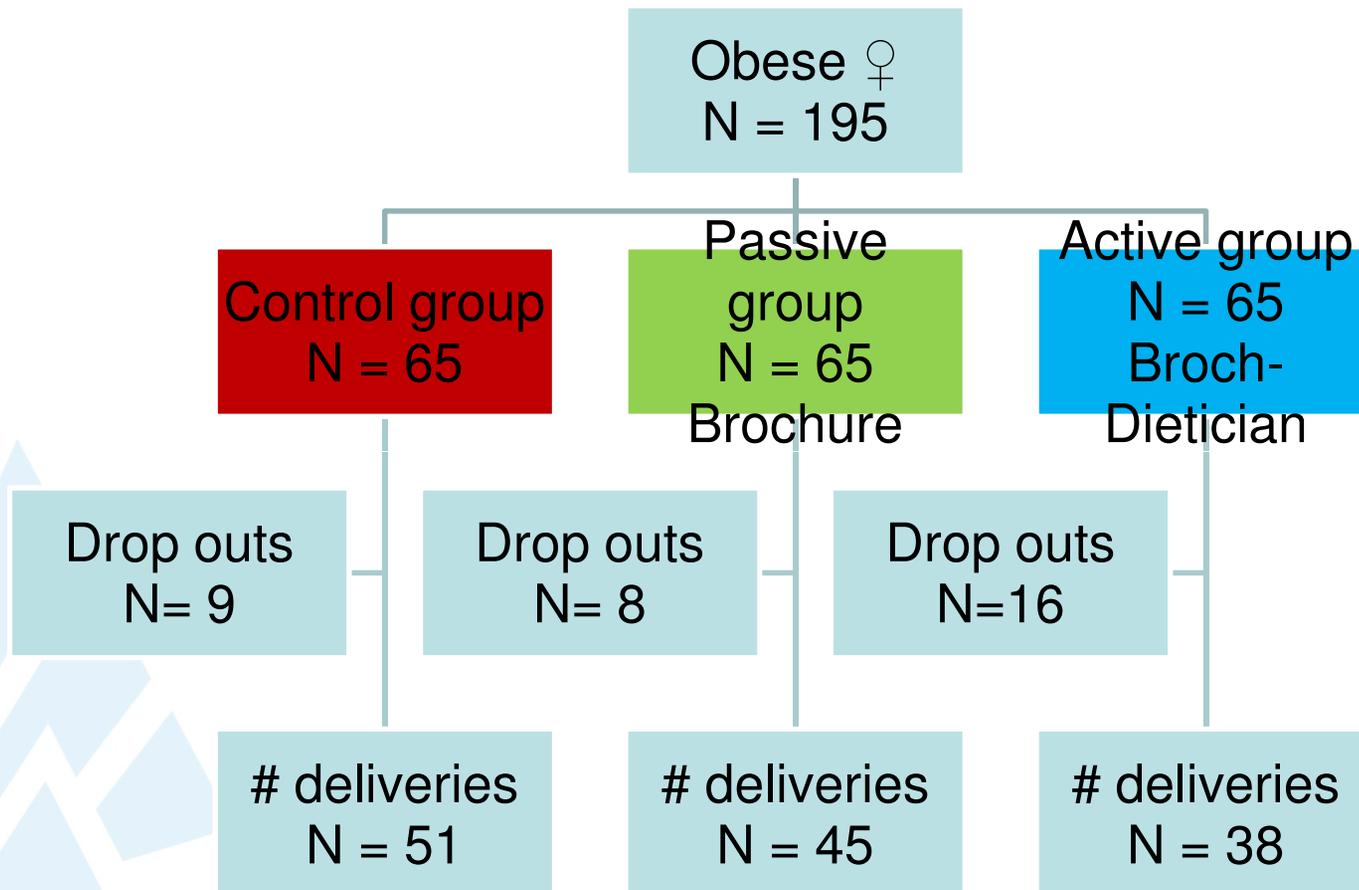
Zwangerschapsduur	Gewicht kg	Gewichtstoename
41		
40	88.5	15.5
38	87.7	14.7
36	87.9	14.9
32 (30-34)	84	11
28 (28-32)	82.2	9.2
24 (24-28)	81.2	8.2
20 (18-22)	77.4	4.4
16	77.7	4.7
12 (11-14)	74.9	1.9
8	75	2
Startgewicht	73	

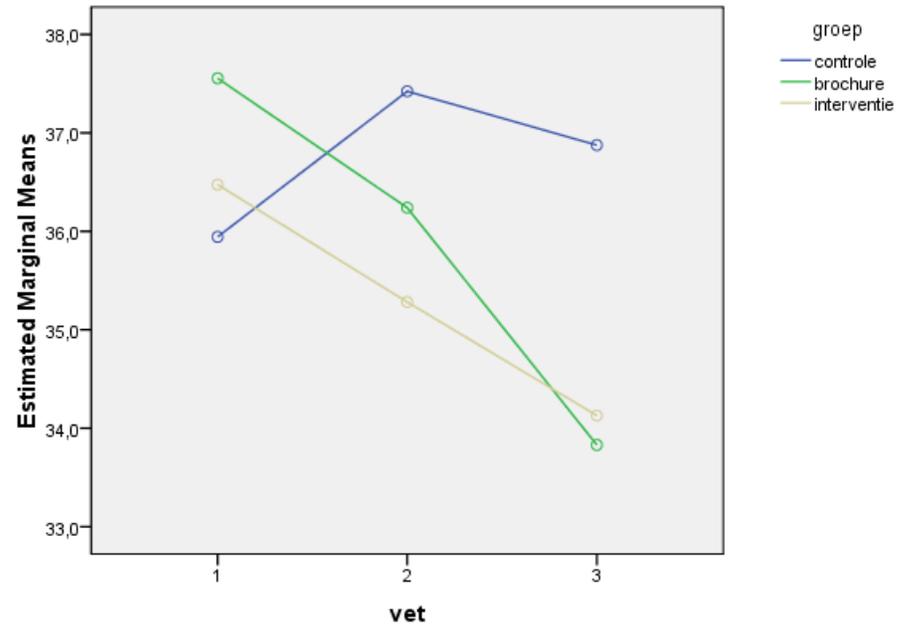
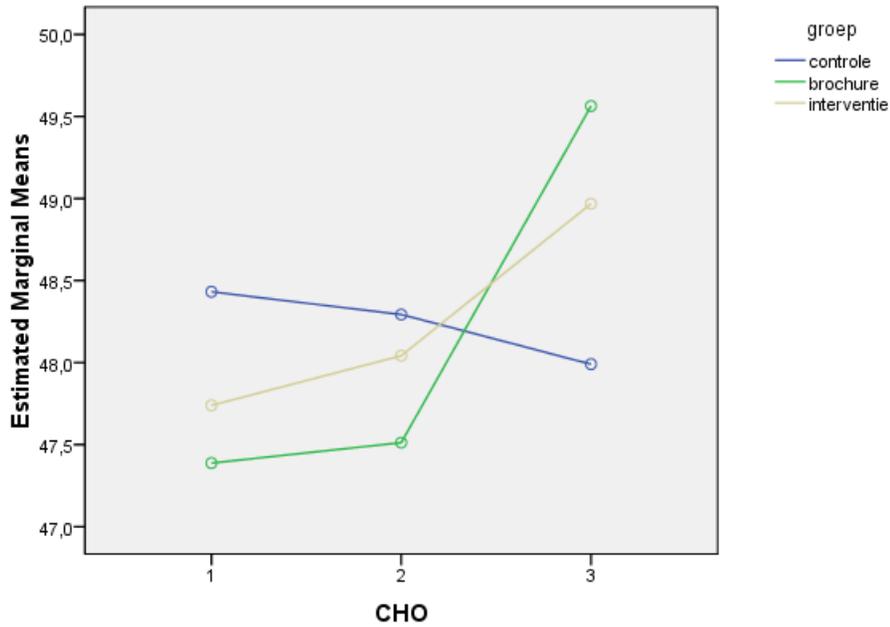
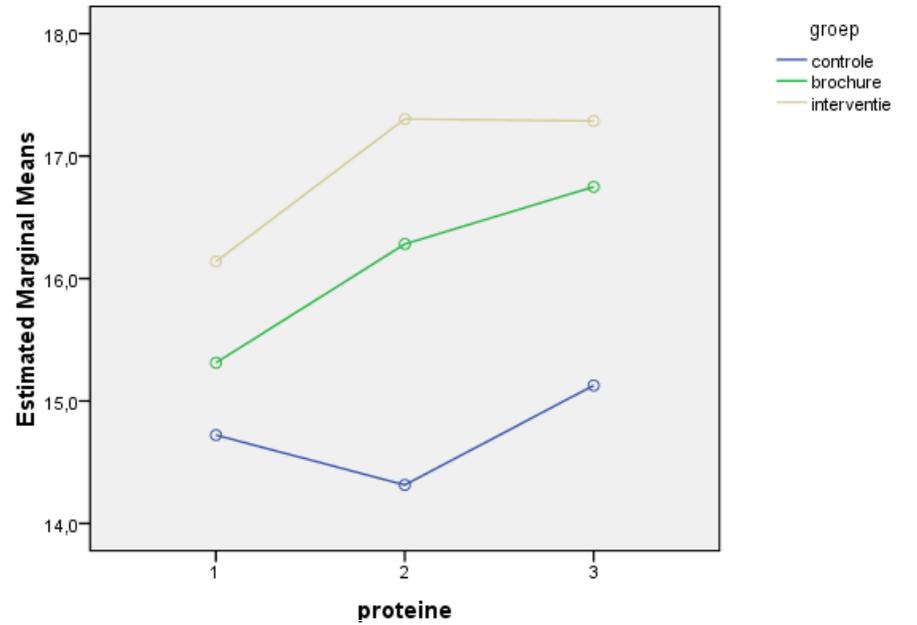
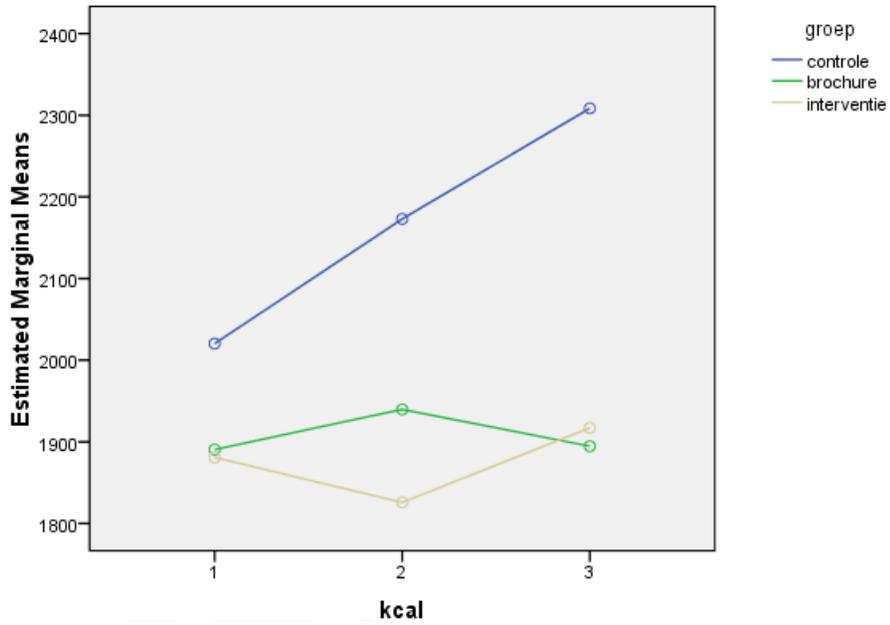


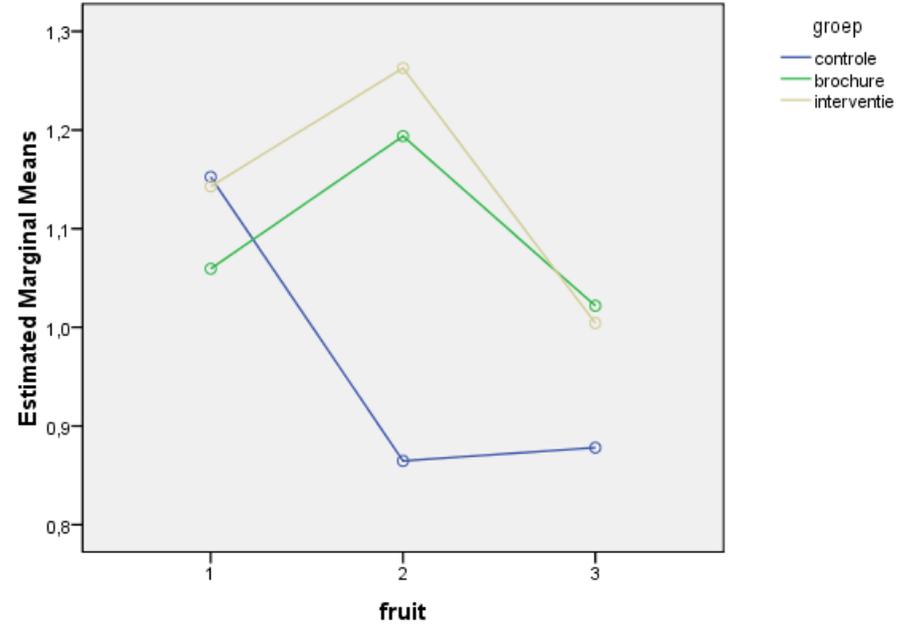
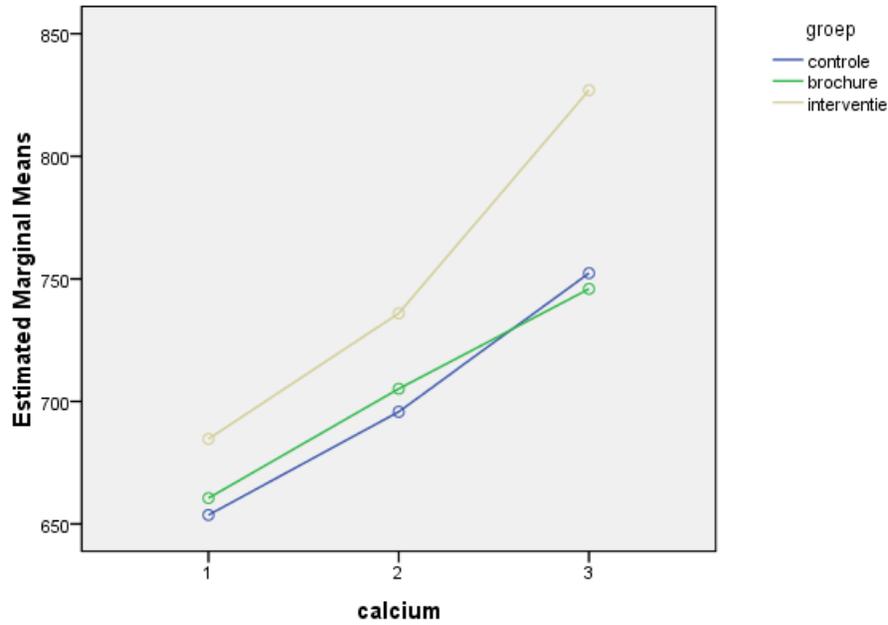
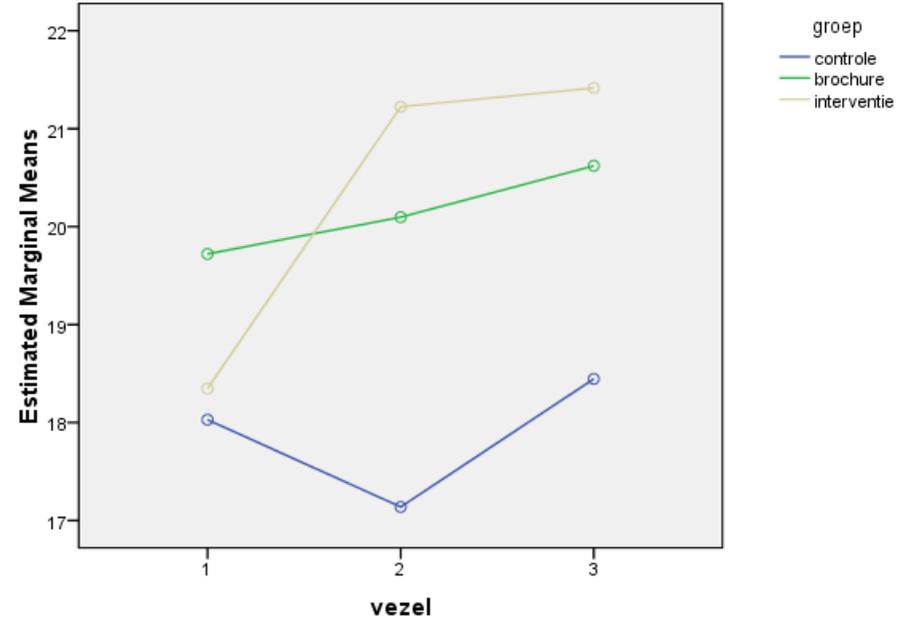
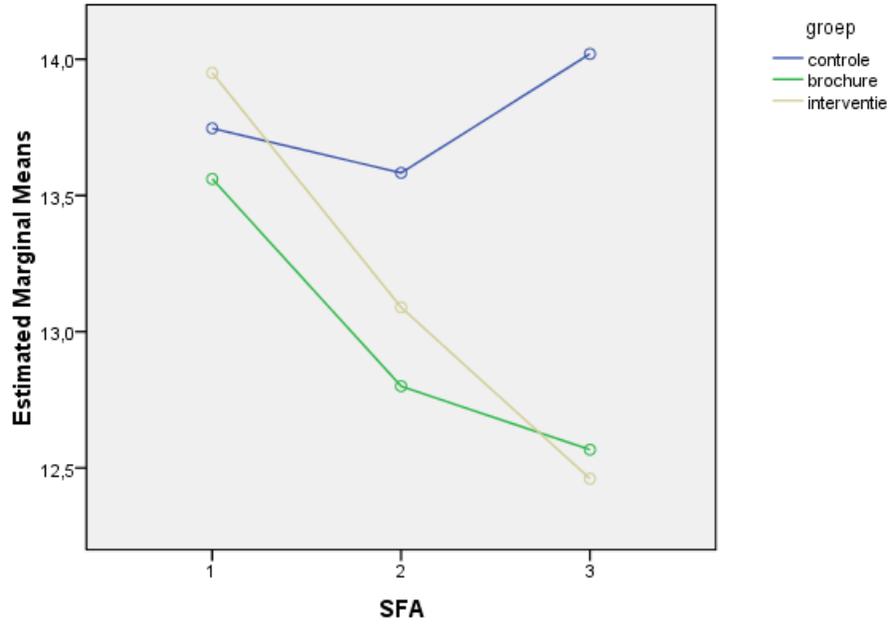
Gewichtstoename bij meting = gewicht bij een meting – startgewicht

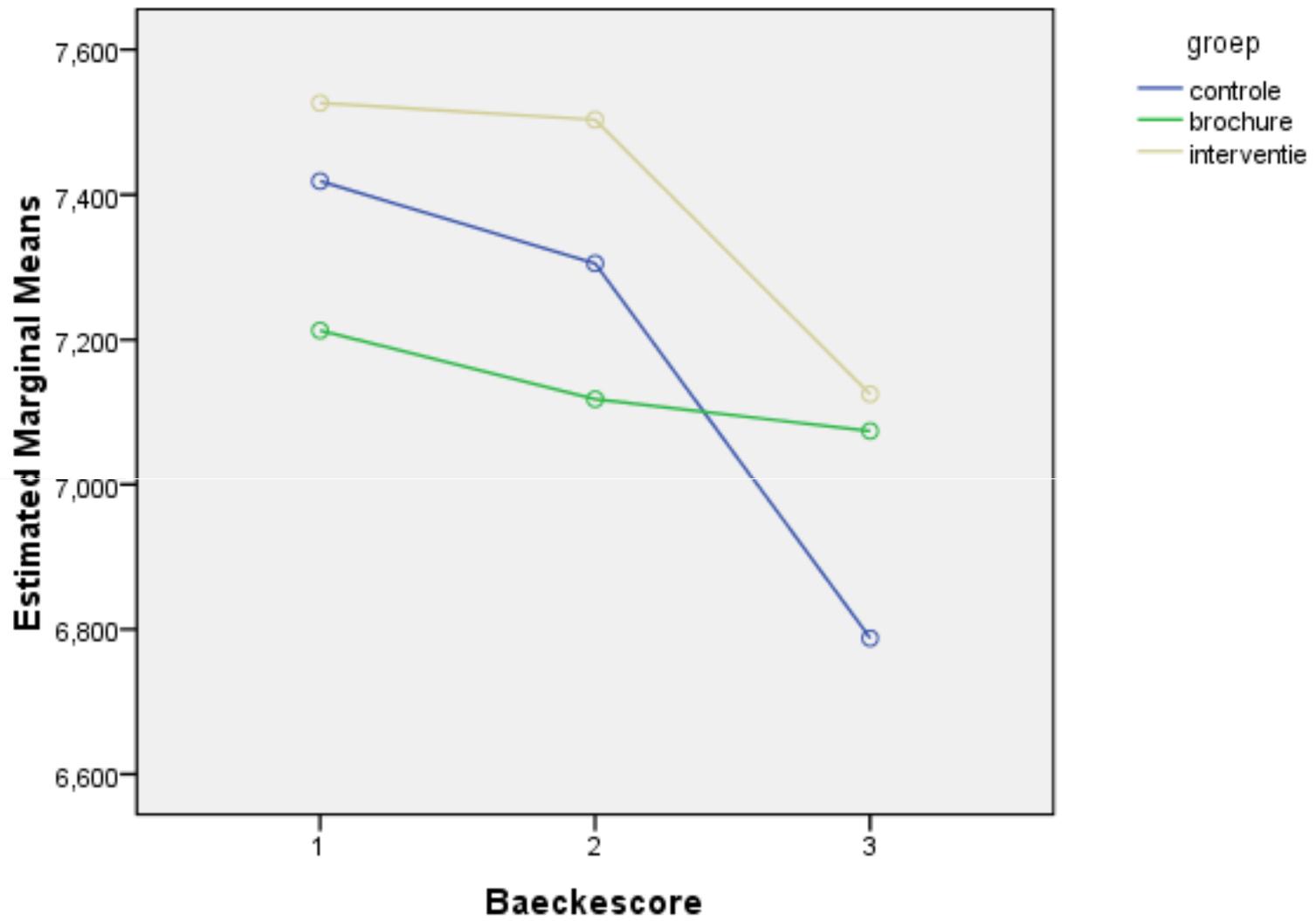
- gemiddelde gewichtstoename
- aanbevolen spreidingsgebied

RCT: effect of life-style advice









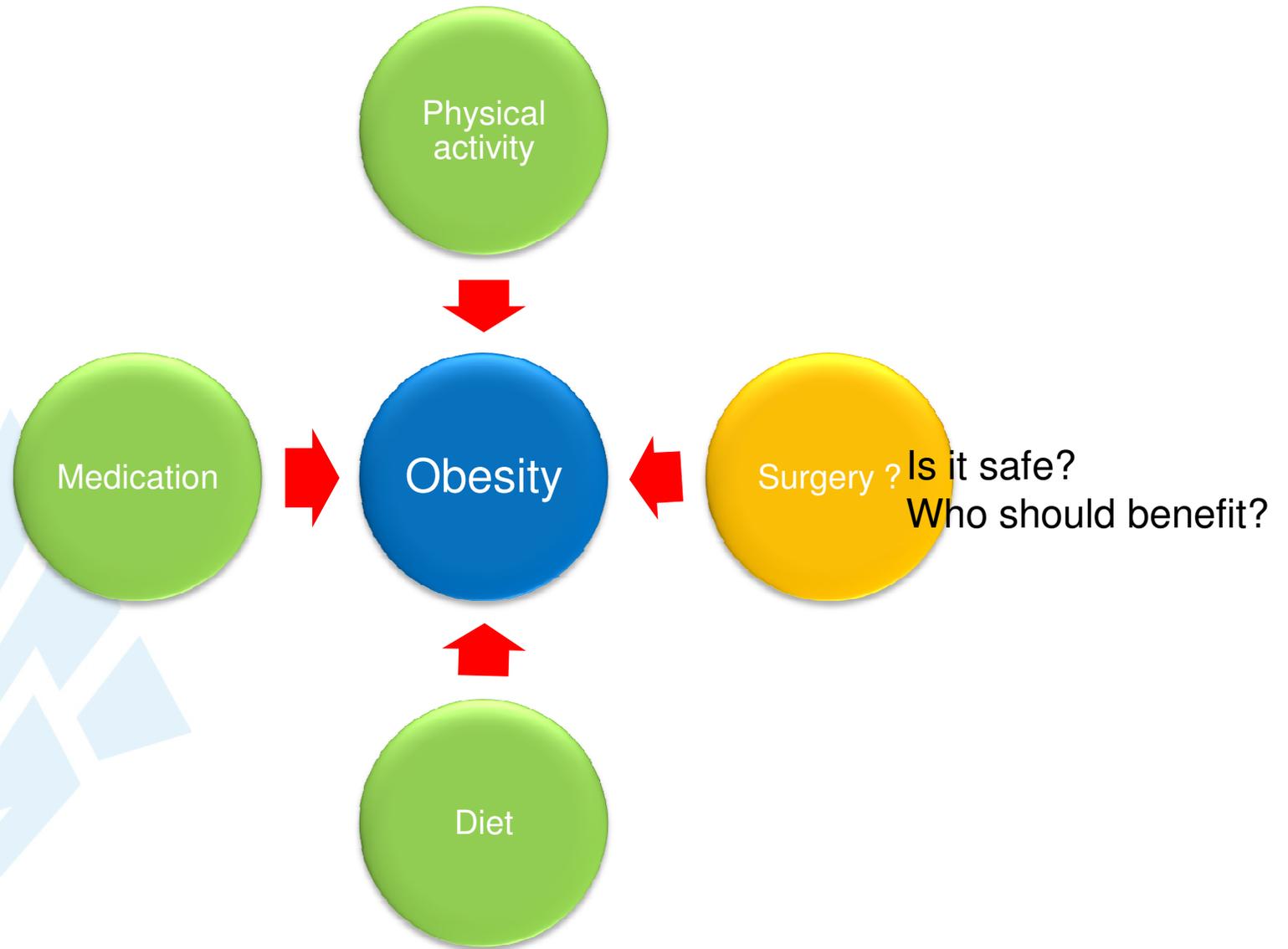
No influence on obstetrical outcome parameters

	Controls	Brochure	Intervention	p
N	51	45	38	
GWG(kg)	10.2 ± 7.2	11.0 ± 6.9	10.3 ± 5.9	ns
Hypertention, Preeclampsia (N,%)	15 (55.6)	10 (33.3)	12 (44.4)	ns
	4 (13.8)	1 (3.4)	1 (3.4)	ns
Inductions (N,%) CSections (N,%)	13 (43.3)	12 (37.5)	18 (60.0)	ns
	4 (12.9)	10 (29.4)	7 (22.6)	ns
Birth weight (kg) Macrosomia (N,%)	3.4 ± 0.4	3.5 ± 0.5	3.5 ± 0.5	ns
	2 (6.5)	4 (11.8)	5 (16.1)	ns

Study	Intervention	Groups of pregnant women:		Weight gain	PA	Nutrition
		Intervention	Controls			
<i>Borberg et al, 1980:</i> RCT	Diet 800-2000 kcal with 150-180g Carbohydrates	10 obese ♀	3 groups of ♀ (underweight, normal weight, obese)		NA	NA
<i>Gray-Donald et al, 2000:</i> Prospective controlled trial	Life-style sessions	112 obese ♀	107 obese ♀	=	=	+
<i>Olson et al, 2004:</i> Prospective cohort	GWG monitoring using graphs and brochures	179 ♀ normal BMI + overweight	381 ♀	=	NA	NA
<i>Polley et al, 2002:</i> RCT	Diet and life-style advice. GWG monitoring using graphs.	30 ♀ normal BMI 27 ♀ overweight	31 ♀ normal BMI 22 ♀ overweight	=	=	NA
<i>Kinnunen et al, 2007:</i> RCT	Individual life style advise	49 obese ♀	56 lean ♀	=	NA	+
<i>Wolff et al, 2007:</i> RCT	10 x individual 1-h consultation	23 obese ♀	27 obese ♀		NA	+

NA not available

Preconceptional treatment of obesity



Mortality Rate After Bariatric Surgery, by Age and Sex

Table 2. Mortality Rate After Bariatric Surgery, by Age and Sex

Age Category (y) and Sex	No.	Mortality Rate, %		
		30 Days	90 Days	1 Year
<25				
Women	150	0.7	1.3	2.0
Men	53	0.0	1.9	1.9
Subtotal	203	0.7	1.5	2.0
25-34				
Women	1341	0.8	1.3	2.5
Men	486	2.1	3.3	4.3
Subtotal	1827	1.1	1.8	3.0
35-44				
Women	3288	1.0	1.5	2.7
Men	1121	3.2	3.7	5.6
Subtotal	4409	1.5	2.0	3.4
45-54				
Women	4214	1.1	1.8	3.1
Men	1191	4.5	5.4	7.7
Subtotal	5405	1.9	2.6	4.1
55-64				
Women	2126	2.0	2.5	4.7
Men	668	2.1	3.1	6.9
Subtotal	2794	2.0	2.7	5.2
65-74				
Women	1039	2.6	3.4	6.2
Men	342	5.8	8.2	12.9
Subtotal	1381	3.4	4.6	7.8
≥75				
Women	85	18.8	28.2	40.0
Men	51	19.6	35.3	51.0
Subtotal	136	19.1	30.9	44.1
Total	16 155	2.0	2.8	4.6

Flum, D. R. et al. JAMA 2005;294:1903-1908.

Indications for Bariatric surgery

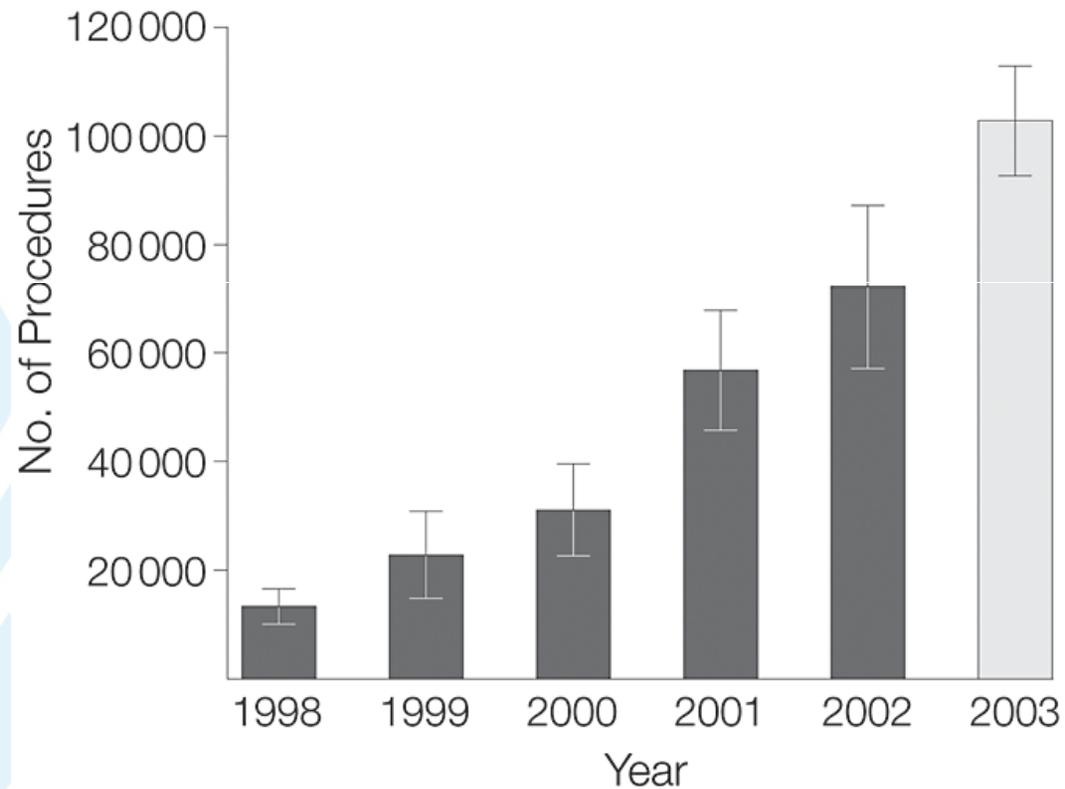
- National Heart, Lung, and Blood Institute Expert Panel on the identification, evaluation, and treatment of obesity for adults
 - bariatric surgery be an option for carefully selected patients with clinically severe obesity (BMI >40 or >35 with comorbid conditions) when less invasive methods of weight loss have failed and the patient is at high risk for obesity-associated morbidity and mortality.
- The American Gastroenterological Association (AGA) medical position statement on obesity
 - most effective approach for achieving long-term weight loss.
 - recommends surgery for patients with a BMI >40, or those with BMI >35 and 1 or more severe obesity-related medical complication (eg, hypertension, heart failure, or sleep apnea) if they have been unable to achieve or maintain weight loss with conventional therapy, have acceptable operative risks, and are able to comply with long-term treatment and follow-up. (5)
- American College of Preventive Medicine
 - policy statement on weight management counseling
 - recommends limiting surgical therapy for obesity to severely obese patients, defined as BMI >40.

Pentin et al, 2005

Indications for bariatric surgery

- Country-specific different reimbursement criteria
- Criteria tend to become more liberal
- Most often used
 - Morbidly obese BMI>40
 - BMI>35 with comorbidities
 - Lifestyle interventions not successful
 - Operative risk acceptable
- Commercial circuit

National Trends in Annual Numbers of Bariatric Procedures, 1998-2003



Santry, H. P. et al. JAMA 2005;294:1909-1917.

Types of Bariatric Surgical Procedures Performed in the United States From 1998 to 2002 Based on Data From the Nationwide Inpatient Sample

Table 2. Types of Bariatric Surgical Procedures Performed in the United States From 1998 to 2002 Based on Data From the Nationwide Inpatient Sample

Procedure Type	No. (%) of Procedures					P Value for Trend*
	1998	1999	2000	2001	2002	
Gastric bypass	10 675 (79.9)	20 421 (89.5)	27 497 (88.5)	48 507 (85.4)	63 538 (88.0)	.27
Gastroplasty†	3295 (24.7)	2097 (9.2)	4357 (14.0)	6247 (11.0)	5369 (7.4)	.01
Malabsorptive‡	990 (7.4)	1277 (5.6)	3684 (11.9)	4732 (8.3)	7495 (10.4)	.54
Gastrectomy§	258 (1.9)	721 (3.2)	495 (1.6)	2186 (3.8)	3082 (4.3)	.30
Other	43 (0.3)	31 (0.1)	70 (0.2)	303 (0.5)	1446 (1.9)	.13
Total No. of procedures¶	13 365	22 809	31 082	56 781	72 177	<.001

*In the proportion of total procedures.

†Includes vertical banded gastroplasty and adjustable gastric banding.

‡Includes duodenal switch, biliopancreatic diversion, and isolated intestinal bypass.

§Includes sleeve gastrectomy and any isolated partial gastrectomy.

||Includes gastric bubble insertion and nonspecified stomach procedures.

¶The numbers in the columns do not add up because they are survey weighted estimates.

Santry, H. P. et al. JAMA 2005;294:1909-1917.

Characteristics of Patients Undergoing Elective Bariatric Surgical Procedures From 1998 to 2002 Based on Data From the Nationwide Inpatient Sample

Table 3. Characteristics of Patients Undergoing Elective Bariatric Surgical Procedures From 1998 to 2002 Based on Data From the Nationwide Inpatient Sample

	No. (%) of Patients*					P Value for Trend†
	1998 (n = 13 365)	1999 (n = 22 809)	2000 (n = 31 082)	2001 (n = 56 781)	2002 (n = 72 177)	
Age, mean (SD), y	39.6 (0.28)	41.5 (0.31)	40.8 (0.28)	40.9 (0.17)	41.7 (0.21)	<.001
Age categories, y						
<18	52 (0.4)	141 (0.6)	119 (0.4)	196 (0.4)	195 (0.3)	.09
18-34	4321 (32.3)	6052 (26.5)	8932 (28.7)	16 312 (28.7)	19 488 (27.0)	.007
35-49	6832 (51.1)	11 301 (49.6)	15 574 (50.1)	27 819 (49.0)	34 732 (48.1)	.01
50-64	2032 (15.2)	5029 (22.0)	6240 (20.0)	12 085 (21.3)	17 055 (23.6)	<.001
>64	127 (1.0)	286 (1.3)	217 (0.7)	368 (0.6)	706 (1.0)	.29
Women	10 782 (81.3)	18 595 (81.6)	26 493 (85.2)	47 714 (84.0)	60 671 (84.1)	.003
Annual income‡						
<\$24 999	605 (4.5)	826 (3.6)	1504 (4.8)	1715 (3.0)	1411 (2.0)	<.001
\$25 000 to \$34 999	3741 (28.0)	6267 (27.5)	7031 (22.6)	11 046 (19.5)	9844 (13.6)	<.001
\$35 000 to \$44 999	4253 (31.8)	7162 (31.4)	8326 (26.8)	13 771 (24.3)	16 122 (22.3)	<.001
≥\$45 000	4269 (31.9)	7858 (34.5)	13 583 (43.7)	29 638 (52.2)	43 055 (59.7)	<.001
Type of insurance						
Private§	10 061 (75.3)	17 135 (75.1)	25 043 (80.6)	46 893 (82.6)	59 835 (82.9)	.001
Medicare	1160 (8.7)	1975 (8.7)	1986 (6.4)	3243 (5.7)	4280 (5.9)	.003
Medicaid	949 (7.1)	1530 (6.7)	2184 (7.0)	2744 (4.8)	3433 (4.8)	.05
Self-pay	702 (5.2)	1160 (5.1)	1580 (5.1)	2800 (4.9)	3552 (4.9)	.06
Other	100 (0.7)	140 (0.6)	197 (0.6)	327 (0.6)	405 (0.6)	.87
Charlson Index						
None	9469 (70.8)	15 228 (66.8)	21 232 (68.5)	37 980 (66.9)	46 329 (64.2)	.001
1	3101 (23.2)	5980 (26.2)	7990 (25.7)	15 390 (27.1)	20 644 (28.6)	<.001
2	605 (4.5)	1285 (5.6)	1480 (4.8)	2791 (4.9)	4198 (5.8)	.16
>2	190 (1.4)	316 (1.4)	319 (1.0)	620 (1.1)	1005 (1.4)	.53

*Unless otherwise indicated.

†In the proportion of patients.

‡Annual household income based on patient's ZIP code of residence as reported by the Nationwide Inpatient Sample.

§Includes fee-for-service and health maintenance organizations.

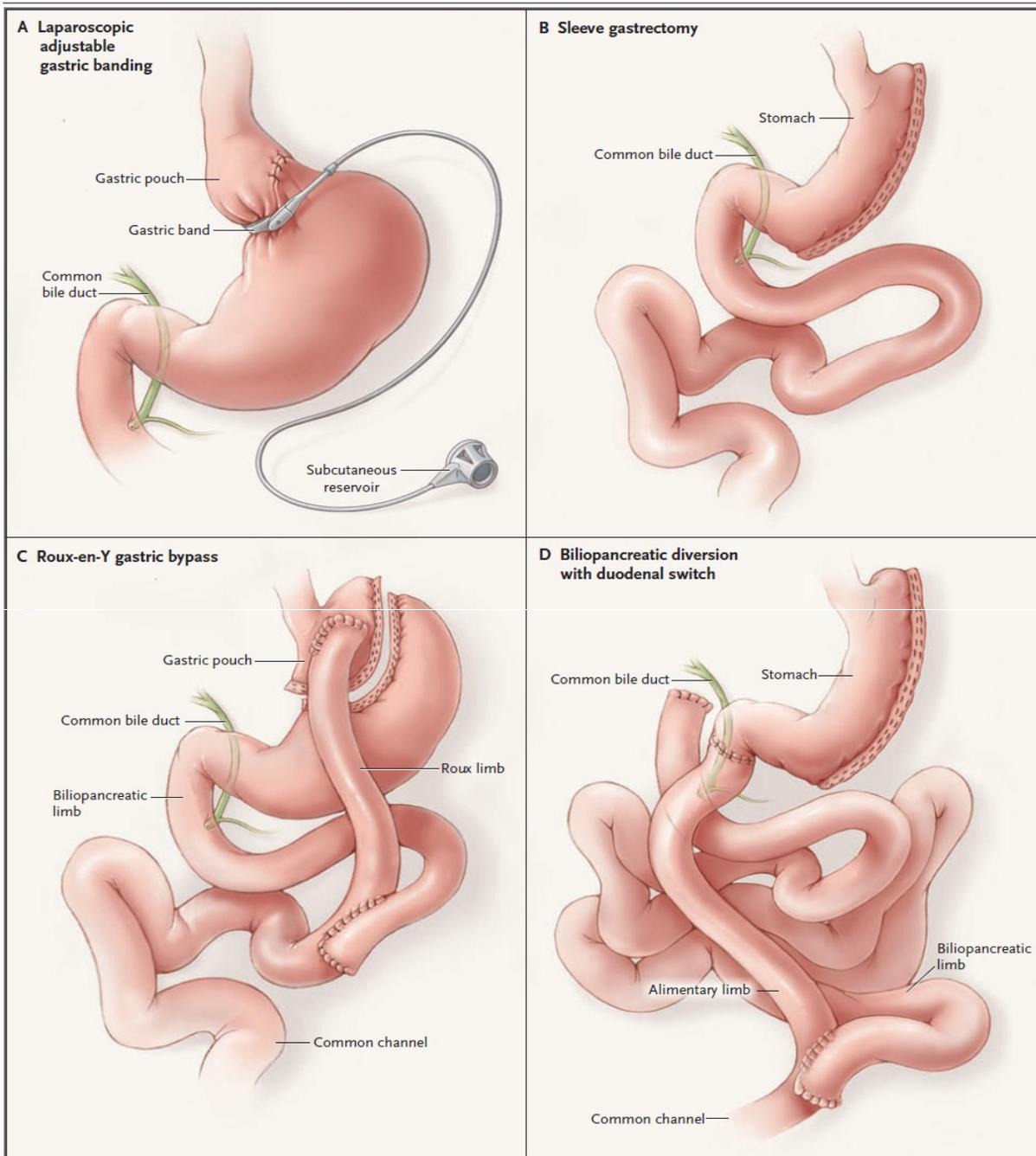
||Using the Deyo adaptation²⁸ of the Charlson Index, which is designed for use with administrative data.

Mostly premenopausal (fertile) women

Santry, H. P. et al. JAMA 2005;294:1909-1917.

Currently used bariatric procedures

- Restrictive operations
 - Laparoscopic Adjustable Gastric Banding = LAGB
 - Sleeve gastrectomy
 - Vertical banded gastroplasty
- Malabsorbtive operations
 - Biliopancreatic diversion
 - BPD with duodenal switch
- Restrictive/Malabsorbtive operations
 - Roux en Y gastric bypass
 - Mini gastric bypass
- Gastric stimulation
 - Gastric pacemaker
 - Intra-gastric electrical stimulation



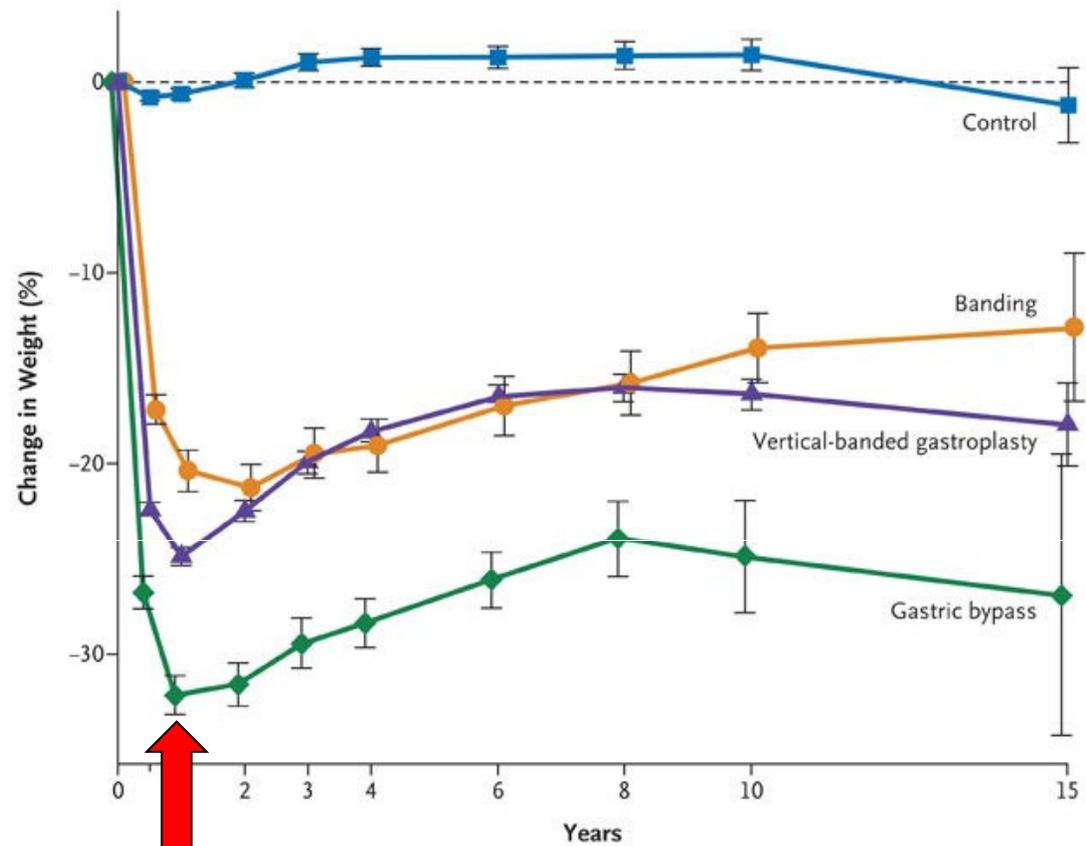
Mechanism of weight loss

- Restrictive procedures
 - Mechanical: decreased stomach volume: rapid feeling of satiation
 - Hormonal pathway:
 - Ghrelin: decreased production in stomach: decreased appetite
 - Peptides produced by intestinal endocrine L-cells: central (n.arquatus) effect: decreased appetite
 - Glucagon-like peptide 1: central effect and endocrine effect on gluconeogenesis
- Malabsorbtive: malabsorbtion
- Mixed: combination of both



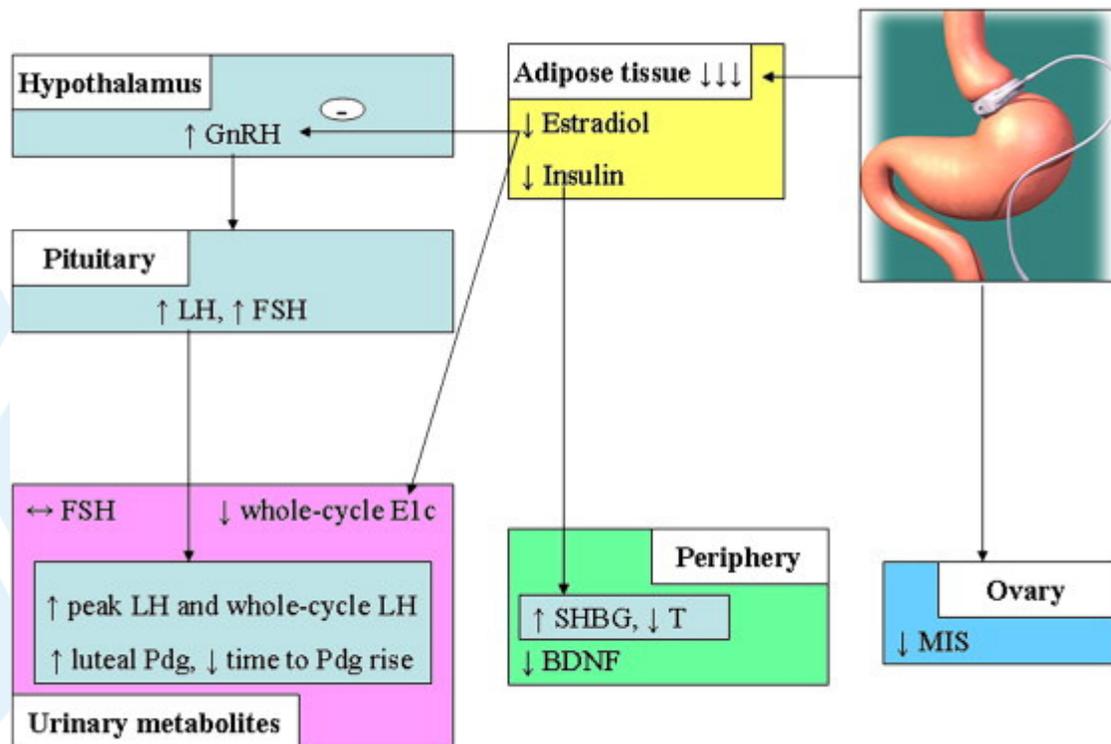
Jacob Jordaens, "Allegory of fertility"

What is the effect of bariatric surgery on fertility?



No. Examined	0	1	2	3	4	6	8	10	15
Control	2037	1818	1660	1553	1490	1281	982	886	190
Banding	376	333	357	328	333	298	267	237	52
Vertical-banded gastroplasty	1369	1118	1244	1121	1086	1004	899	746	108
Gastric bypass	265	245	245	211	209	166	92	58	10

Influence of bariatric surgery on fertility



Authors (reference)	Sample size	Design	Summary of findings
<i>Bastounis et al. (38)</i>	38	Prospective study	Normalization of menstrual cycle irregularities
<i>Rochester et al. (41)</i>	25	Prospective study	Partial recovery of luteal function
<i>Merhi et al. (48)</i>	18	Prospective study	Drop in plasma BDNF
<i>Manco et al. (49)</i>	10	Prospective study	Increase in free cortisol, FCI, and insulin sensitivity. Decrease in CBG and insulin secretion
<i>Chikunguwo et al. (51)</i>	86	Prospective study	Decrease in TSH. No change in free T ₄
<i>Moulin de Moraes et al. (52)</i>	72	Prospective study	Decrease in TSH. No change in free T ₄
<i>Eid et al. (66)</i>	24	Historical cohort	Spontaneous conception in 5 PCOS women
<i>Deitel et al. (62)</i>	30	Case series	Spontaneous conception in 9 women and regulation of the menstrual cycle
<i>Martin et al. (64)</i>	20	Clinical trial	Spontaneous conception in 5 women. No obvious fetal or neonatal effects
<i>Bilenka et al. (63)</i>	6	Retrospective study	Spontaneous conception in 5 women and reduction in the risk of miscarriage
<i>Friedman et al. (89)</i>	1,136	Retrospective study	Reduction in the risk of miscarriage and decrease in pregnancy complications
<i>Marceau et al. (65)</i>	783	Cross-sectional study	Normalization of gestational weight changes and reduction of fetal macrosomia
<i>Sheiner et al. (67)</i>	28	Historical cohort	No difference in obstetric characteristics, pregnancy outcome, or perinatal outcome. Higher rates of fertility treatments
<i>Merhi et al. (73)</i>	16	Prospective study	Drop in plasma MIS
<i>Gerrits et al. (39)</i>	40	Prospective study	Unintended pregnancies in 2 of 9 morbidly obese women despite OCP use
<i>Victor et al. (40)</i>	7	Prospective study	Lower plasma OCP metabolites levels
<i>Kinzl et al. (98)</i>	82	Cross-sectional study	Enhanced sexual function
<i>Camps et al. (99)</i>	94	Cross-sectional study	Enhanced sexual function
<i>Hafner et al. (100)</i>	83	Cross-sectional study	Enhanced sexual function

Bariatric surgery and oral contraceptives

Author	Design	N	Surgery	Findings
Gerrits et al, 2003	Prospective study	40	Biliopancreatic diversion	2/9 unplanned pregnancies in OAC using group
Victor et al, 1996	Prospective study	7	Jejuno-ileal bypass	Lower OAC serum levels



Effect of bariatric surgery on pregnancy outcome



R Magritte "la reproduction interdite" 1937

Problems with literature

- Different types of surgery
- Surgical publications tend to be more optimistic than obstetric or neonatal publications
- Few prospective studies
- Small cohorts, case series, case reports
- Case-control studies with variable controls
 - Same preoperative BMI
 - Same preconceptional BMI
 - Pregnancy before the surgery

Recent reviews on the subject

Pregnancy and Fertility following bariatric surgery: **A systematic review**

JAMA 2008; 300:2286-2296

Maggard MA, Yermilov I, Li Z, et al

Pregnancy after bariatric surgery: **A comprehensive review**

Arch Gynecol Obstet 2008; 277:381-388

Karmon A, Sheiner E

Reproductive outcome after bariatric surgery: **A critical review**

Human Reproduction update 2009; 15:189-201

Guelinckx I, Devlieger R, Vansant G.



Reference	Type of surgery	Study population, prepregnancy age and BMI	Controls	Significant positive changes compared with control group	Significant negative changes compared with control group	No change compared with control group
Sheiner et al. (2006)	Mixture	28 with GDM age 28.6 y, 3.6% obese	7986 with GDM age 30.8 y, 1.5% obese	Low complication rate of surgery	selffertility treatments	Pregnancy, perinatal or labour characteristics
Sheiner et al. (2004)	Mixture	298 age 29.1 ± 5.7 y, 10.4% obese	158 912 age 28.3 ± 5.9 y, 1.2% obese		fertility treatment PROM labour induction failed induction CS macrosomia IUGR	Other pregnancy or perinatal complications, gestational age
Deitel et al. (1988)	Mixture	7 with 9 pregnancies no age/BMI available	86 with 274 pregnancies	fertility GDM PIH PET venous thrombosis CS		Birthweight
Ducarme et al. (2007)	LAGB	13 age 31.5 ± 5.7 y, BMI 34.8 ± 3.2 kg/m ²	414 age 31.0 ± 6.0 y, BMI 35.8 ± 4.0 kg/m ²	GDM PET spontaneous vaginal delivery VBAC CS GWG macrosomia low birthweight PET spontaneous vaginal delivery VBAC CS GWG macrosomia low birthweight	macrosomia	Labour induction, PIH, pregnancy duration, post-partum haemorrhage
Dixon et al. (2005)	LAGB	79 pregnancies, age 29.9 ± 4.7 y, no BMI available	1) Pre-LAGB pregnancies 2) Obese matched controls	GDM PIH PET GWG macrosomia low birthweight		Birthweight
Skull et al. (2004)	LAGB	49 pregnancies, age 31 y, BMI 32.8 kg/m ²	Same with 31 preoperative pregnancies, age 27 y, BMI 34.1 kg/m ²	GDM PIH PET GWG		Obstetric complications, CS Neonatal complications
Bilenka et al. (1995)	VBG	9 with 14 pregnancies, age 32 ± 5 y, weight loss 35 ± 11 kg, no BMI available	Same 9 with 18 pregnancies, 1 terminated mean BMI 42.2 ± 4.6 kg/m ²	fertility spontaneous miscarriage complicated pregnancies Normal birthweights		
Patel et al. (2008)	RYGB	26, age 34.1 ± 4.5 y, BMI 32.5 ± 7.2 kg/m ²	188 non-obese, 39 obese and 27 severely obese controls	Comparable to non-obese and obese control: GWG, fetal birthweight, macrosomia and CS	Comparable to severely obese: SGA and anaemia 2 cases with small bowel obstruction	GDM PIH
Wittgrove et al. (1998)	RYGB	40 with 49 pregnancies, no age/BMI available	17 preoperative pregnancies	GDM CS GWG macrosomia No anaemia		PET Premature delivery Preterm delivery
Marceau et al. (2004)	BPD	132 with 251 pregnancies no age/BMI available	594 with 1577 pregnancies	fertility Normal GWG macrosomia	SGA 2.5% albumin deficient, requiring PN	High miscarriage rate, premature delivery, stillbirths, malformation
Richards et al. (1987)	RYGB	57 pregnancies, age 32 ± 5 y, no BMI available	57 controls matched to preoperative weight age 29 ± 4y	PIH GWG average birthweight		CS, premature delivery, blood transfusion, SGA, perinatal death

Reference	Surgery	Study population, age (y), BMI (kg/m ²)	sAB (%)	GDM (%)	PIH (%)	PET (%)	PTD (%)	CS (%)	Macrosomia (%)	SGA (%)	Others (%)
Bar-Zohar et al. (2006)	LAGB	81 pregnancies, NA age NA, BMI 30.3±3		16	7.4	NA	NA	20.0	NA	NA	2.4% band slippage resulting vomiting, dehydration, electrolyte disturbances
Dixon et al. (2001)	LAGB	22 pregnancies, 4.3 age 28.8 ± 4.4, BMI 35 ± 7		4.5	4.5	NA	0	13.6	4.5	0	1 patient with hyperemesis, requiring post-natal removal of all fluid in LAGB 1 patient with symptomatic gallstones
Weiss et al. (2001)	LAGB	7 pregnancies, 28.6 age 33 ± 4.1, BMI 34.8 ± 5.8		0	0	0	0	28.6	0	14.3	1 intragastric band migration, 1 balloon defect, required re-operation
Martin et al. (2000)	LAGB	23 pregnancies, 8.7 age 29, BMI NA		0	0	0	0	22.2	0	0	
Dao et al. (2006)	RYGB	Early group	23.8	0	4.8	0	4.8	40.0	0	NA	4.8% anaemia, 4.8% cholelithiasis requiring hospitalization
		Late group	0	0	0	7.7	15.4	58.8	0	NA	0% nutritional deficiencies, 7.7% placental abruption
Friedman et al. (1995)	BPD	152 pregnancies, age 31.4, BMI NA	11.4	0	0.7	9.0	15.3	44	NA	27.8	1.3% Perinatal deaths, 21% required TPN
Printen and Scott (1982)	BPD	54 pregnancies, 4.0 age NA, BMI NA		NA	NA	NA	15.2	10.5	NA	18.4	2.6% microcephalic child, 5.3% required parenteral iron, 2.6% perinatal death

<i>Reference</i>	<i>Type of surgery</i>	<i>Interval operation and pregnancy</i>	<i>Maternal complication</i>	<i>Fetal complication</i>	<i>Long-term outcome</i>
Wang et al. (2007)	RYGB	2 months	Internal hernia		Uncomplicated
Wax et al. (2007a, b)	RYGB	12 months	Intussusception		Uncomplicated
Bellanger et al. (2006)	RYGB	24 months	Small bowel obstruction		Uncomplicated
Ahmed and O'Malley (2006)	RYGB	8 months	Internal hernia		Uncomplicated
Baker and Kothari (2005)	RYGB	4 months	Internal hernia		Uncomplicated
Loar et al. (2005)	RYGB	NA	Small bowel volvulus	Preterm delivery	Maternal death Uncomplicated Uncomplicated
Kakarla et al. (2005)	RYGB	9 months	Internal herniation	Preterm delivery	
Kakarla et al. (2005)	RYGB	30 months	Small bowel herniation		
Charles et al. (2005)	RYGB	6 months	Small bowel herniation		Uncomplicated
Moore et al. (2004)	RYGB	18 months	Small bowel herniation		Maternal + fetal deaths
Graubard et al. (1988)	BPD	3 years	Small bowel obstruction leading to maternal death	Fetal death	Maternal + fetal deaths
Smets et al. (2006)	BPD	8 years	Vit A deficiency	Bilateral microphthalmia	—
Huerta et al. (2002)	BPD	13 years	Vit A deficiency	Vit A deficiency	Unknown
Grange and Finlay (1994)	BPD	24 months	Subclinical Vit B ₁₂ deficiency	Failure to thrive, anaemia and neutropenia	Uncomplicated
Wardinsky et al. (1995)	RYGB	6 years	Vit B ₁₂ deficient breast milk	macrocytic anaemia, Vit B ₁₂ and folate deficient	Uncomplicated
Campbell et al. (2005)	GB	32 months	Asymptomatic Vit B ₁₂ deficiency	Asymptomatic Vit B ₁₂ deficiency	Uncomplicated
Gurewitsch et al. (1996)	GB	4 years	Iron deficiency anaemia		Uncomplicated
Martens et al. (1990)	GB	16 months	Anaemia during pregnancy, low fat content breast milk	Failure to thrive	Uncomplicated
Adami et al. (1992)	BPD	2 months	Severe protein malnutrition requiring PN via central vein	Reduced fetal growth	Uncomplicated with normal weight baby
Adami et al. (1992)	BPD	3 years	Severe protein malnutrition requiring PN via central vein	Reduced fetal growth	Uncomplicated with normal weight baby
Adami et al. (1992)	BPD		11 cases with moderate malnutrition requiring PN via peripheral	5 SGA babies	Uncomplicated

<i>Reference</i>	<i>Type of surgery</i>	<i>Interval operation and pregnancy</i>	<i>Maternal complication</i>	<i>Fetal complication</i>	<i>Long-term outcome</i>
Wang et al. (2007)	RYGB	2 months	Internal hernia		Uncomplicated
Wax et al. (2007a, b)	RYGB	12 months	Intussusception		Uncomplicated
Cools et al. (2006)	BPD	3 years	Abdominal pain at 33 weeks	Fetal hydrops, congenital abnormalities, anaemia, prolonged coagulation	Perinatal death
Cools et al. (2006)	BPD	2 months	Unknown	Unknown	Failure to thrive
Cools et al. (2006)	BPD	2 years	Nutritional deficiencies, hypoplastic anaemia,	Multiple congenital abnormalities, preterm delivery, severe anaemia,	Severe retardation, epilepsy, blind, deaf
Cools et al. (2006)	BPD	18 months	Nutritional deficiencies no gestational weight gain	Preterm delivery	Uncomplicated
Cools et al. (2006)	BPD	3 years	Preterm contractions 22 weeks		Perinatal death
Cools et al. (2006)	BPD	5 years	Preterm contractions 27 weeks	Hydrocephaly, atrophy, hypoplastic corpus callosum	Retarded, vision disturbances, VP shunt
Cools et al. (2006)	BPD	7 years	Nutritional deficiencies preterm contractions for which cerclage	Preterm delivery	Uncomplicated
Cools et al. (2006)	BPD	18 months	Nutritional deficiencies no gestational weight gain	Cystic and haemorrhagic zones bilateral frontoparietal, anaemia, nutritional deficiencies, prolonged coagulation	Epilepsy, good development at age of 2 months
Granstrom et al. (1990)	Mason	15 months	Malnutrition due to recurrent vomiting	growth retardation and oligohydramnions	Uncomplicated
Weissman et al. (1995)	Mason	11 years	Pre- and post-natal electrolyte imbalances, due to recurrent vomiting	Electrolyte imbalances	Perinatal death, uncomplicated for mother
Ramirez (1995)	Mason	4 years	GI haemorrhage after erosion of band	CS for abruptio placentae	Uncomplicated
Van Mieghem et al. (2008)	LAGB	2 years	Vitamin K deficiency	Cerebral haemorrhage	Perinatal death
Erez (2004)	LAGB	24 months	Perforated gastric ulcer	Preterm CS	Uncomplicated

Type of surgery and pregnancy risks

<i>Outcome</i>	<i>Mixture of procedures¹</i>	<i>Restrictive procedures²</i>	<i>RYGB³</i>	<i>Malabsorptive procedures⁴</i>
Mean birthweight	3.275 (3.195–3.398)	3.276 (2.11–3.86)	2.938 (2.727–3.205)	2.926 (2.151–3.5)
GDM	4.3 (0–9.4)	4.3 (0–16)	2.4 (0–5.3)	0
PIH	7.7 (0–17.9)	5.2 (0–10)	3.5 (0–9.0)	0.7
PET	2.9 (0–5.7)	2.1 (0–7.7)	3.8 (0–7.7)	9.0
PTD	10.4	2.3 (0–7.7)	14.0 (4.8–26.9)	14.7 (13.6–15.3)
CS	20.3 (0–35.7)	18.3 (0–28.6)	44.3 (25.0–61.5)	24.9 (10.5–44.0)
GWG	NA	9.0 (3.7–15.6)	11.1 (1.8–15.4)	5.6 (1.5–9.1)
Neonatal deaths	0.1 (0–0.3)	1.3 (0–7.7)	0.7 (0–3.5)	2.0 (1.3–2.6)

Data are presented as mean (min–max). If only one study reported on the variable, no range is available.

CS, Caesarean section; GDM, gestational diabetes mellitus; GWG, gestational weight gain; NA, not available; PET, pre-eclampsia; PIH, pregnancy-induced hypertension; PTD, preterm delivery; RYGB, Roux-en-Y gastric bypass.

¹Deitel *et al.*, 1988; Sheiner *et al.*, 2006; Sheiner *et al.*, 2004.

²Bab-Zohar *et al.*, 2006; Bilenka *et al.*, 1995; Dixon *et al.*, 2005; Dixon *et al.*, 2001; Ducarme *et al.*, 2007; Skull *et al.*, 2004; Weiss *et al.*, 2001.

³Dao *et al.*, 2006; Patel *et al.*, 2008; Richards *et al.*, 1987; Wittgrove *et al.*, 1998.

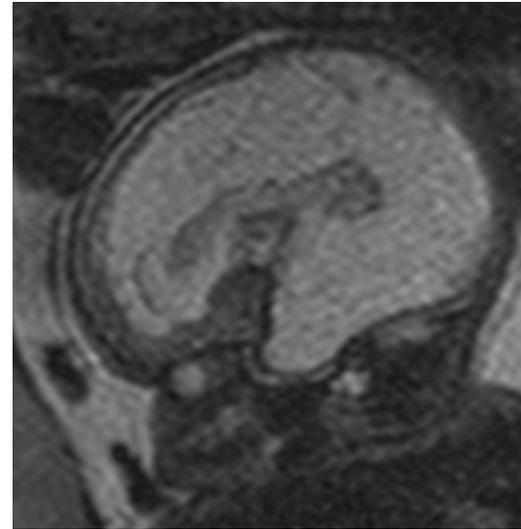
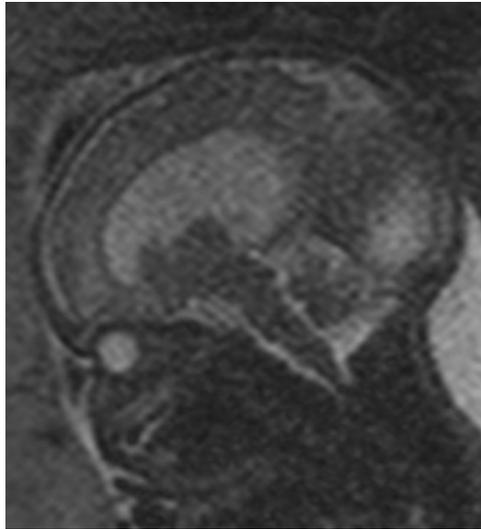
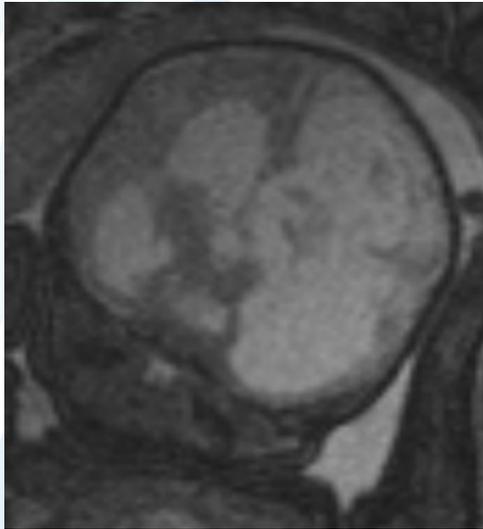
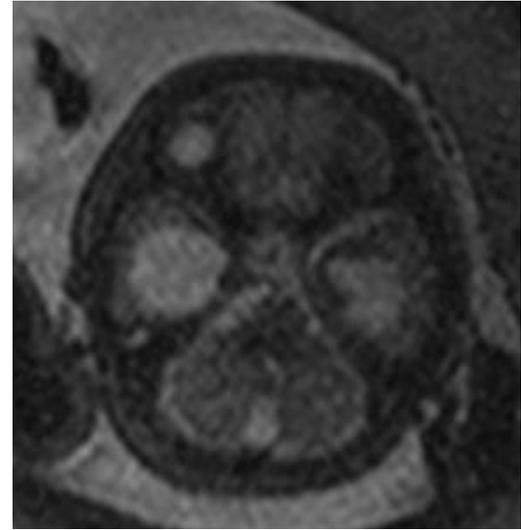
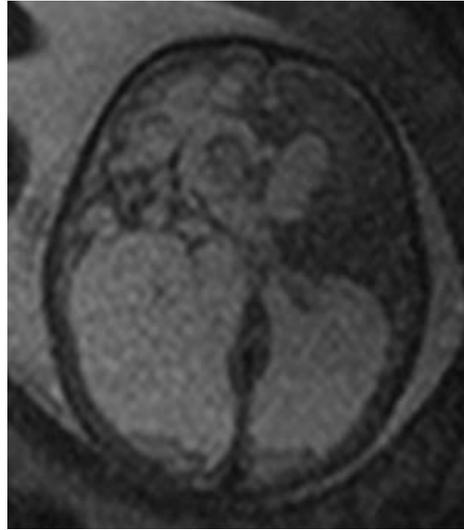
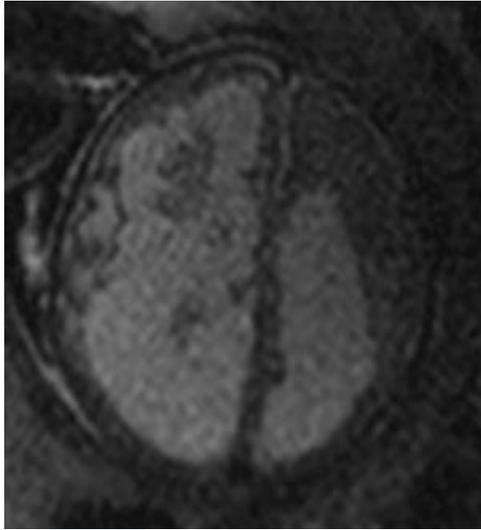
⁴Friedman *et al.*, 1995; Marceau *et al.*, 2004; Printen and Scott 1982.

Effects on reproduction: summary

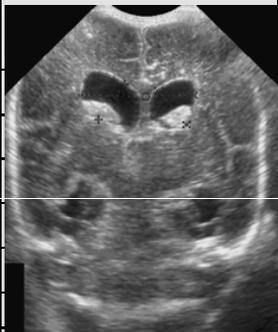
Improvement	<i>Fertility</i> <i>Hypertensive disorders</i> <i>GDM</i> <i>LGA</i> <i>Excessive GWG</i>
Worsening	<i>SGA</i> <i>Surgical complications</i> <i>Nutritional deficiencies</i> <i>Prematurity?</i>
No effect	<i>Caesarean section</i> <i>Prematurity?</i>
No data	<i>Miscarriages</i> <i>Weight retention</i> <i>lactation</i>







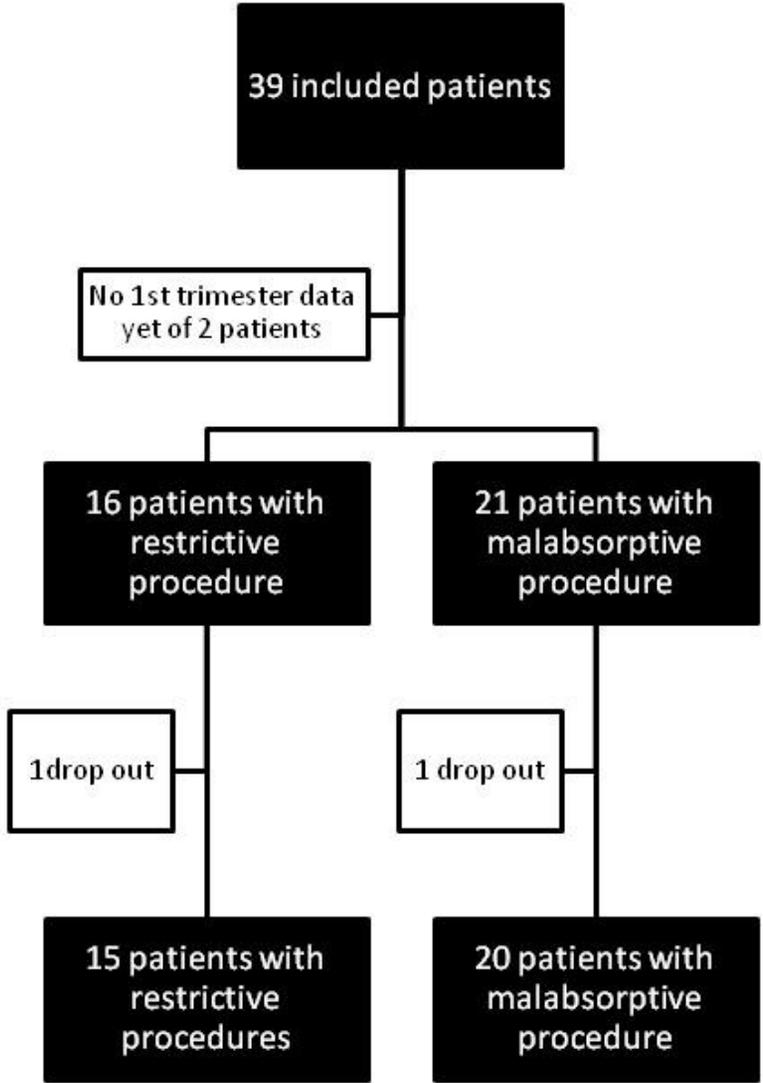
Neonatal adverse cases

	Case 1	Case 2	Case 3	Case 4	Case 5
Type of bariatric surgery	Gastric banding	Gastric banding	Gastric banding	Biliopancreatic diversion	Duodenal switch
Laboratory values mother	PT 46.8% (70–150%)	Pseudo-Bartter			Vitamin K 0.0008 nmol/L (0.8–5.3 nmol/L)
	aPTT 29.3 s (24–31 s)	K ⁺ 2.29 mmol/L (3.5–5.1 mmol/L)			
	f II 56% (70–130%)				
	f V 121% (70–130%)				
	f VII 40% (70–130%)				
	f IX 75 % (70–130%)				
	f X 27% (70–130%)				
	Vitamin K1 0.2 nmol/L (0.8–5.3 nmol/L)				
Laboratory values infants	PT < 10% (70–100%)	Pseudo-Bartter	PT 16.8% (70–100%)	PT 53% (70–100%)	
	aPTT 121.2 s (24–38 s)	K ⁺ 2.42 mmol/L (3.5–5.1 mmol/L)	aPTT 93.4 s (24–38 s)	aPTT 38 s (24–38 s)	
	Fibrinogen 1.29 g/L (2.00–3.80 g/L)		Fibrinogen 0.93 g/L (2.00–3.80 g/L)		
	f II 13% (70–130%)	HCO ₃ ⁻ 27.8 mmol/L (22–29 mmol/L)	f II 18% (70–130%)		
	f V 78% (70–130%)		f V 50% (70–130%)		
	f VII 2.9% (70–130%)		f VII 2.6% (70–130%)		
	f IX 0.8% (70–130%)		f IX 8% (70–130%)		
	f X 4.2% (70–130%)		f X 13% (70–130%)		
Neonatal outcome	Died	Died	Mental retardation	Mental retardation	Died

Prospective, observational, multicentric cohort

PABAS study (*Pregnancy After BAriatric Surgery*)





	Restrictive procedure N = 15	Malabsorptive procedure N = 20	P - value
Age (years)	29.9 ± 2.6 (25 – 36)	30.3 ± 5.1 (22 – 38)	0.789
Height (m)	1.65 ± 0.1 (1.50 – 1.74)	1.66 ± 0.1 (1.57 – 1.80)	0.815
Preoperative weight (kg)	107 ± 13 (88 – 127)	115 ± 19 (88 – 150)	0.224
Preoperative Body Mass Index (kg/m ²)	39 ± 4 (33 – 46)	42 ± 6 (32 – 57)	0.302
Maximum postoperative weight loss (kg)	32 ± 14 (18 – 56)	45 ± 16 (22 – 79)	0.010
Interval between surgery and conception (months)	39 ± 22 (6 – 72)	32 ± 23 (2 – 79)	0.301
Prepregnancy weight (kg)	85.0 ± 16 (63.0 – 110.0)	74.3 ± 14.9 (55 – 112)	0.069
Prepregnancy Body Mass Index (kg/m ²)	31.4 ± 5.9 (22.3 – 44.4)	27.0 ± 5.0 (20.1 – 39.1)	0.028
nulliparae	5 (39)	5 (25)	0.461
smokers	5 (39)	6 (29)	0.709

Fat soluble vitamin levels 1st trimester

	Reference value	Restrictive procedure N = 15	Malabsorptive procedure N = 20	P-value
Vitamin A (µg/l)				
Mean ± SD	300 - 650	368 ± 116	397 ± 85	0.399
Normal		87 %	89 %	
Deficient		13 %	11 %	0.626
25-OH-Vitamin D (µg/l)				
Mean ± SD	7.0 - 60.0	26 ± 15	23 ± 14	0.700
Normal		57 %	71 %	
Deficient < 20 µg/l		36 %	7 %	
Deficient < 7 µg/l		7 %	22 %	0.143
Vitamin E (mg/l)				
Mean ± SD	5.0 - 20.0	12 ± 2	12 ± 2	0.542
Normal		100 %	100 %	
Vitamin K (nmol/l)				
Mean ± SD	0.8 - 5.3	0.5 ± 0.3	0.4 ± 0.3	0.233
Normal		20 %	11 %	
Deficient		80 %	89 %	0.409

concentration of vitamin K in the neonate is only 20% that of adult

- Immaturity of the neonatal liver,
- Low vitamin K content of breast milk
- Sterile gut
- Poor placental transfer of vitamin K

Dietary habits 1st trimester

	Restrictive procedures N = 15	Malabsorptive procedures N = 20	P-value
Energy Intake (kcal/day)	1915 ± 399	1794 ± 317	0.369
Protein Intake (E%)	15.2 ± 1.5	15.6 ± 2.3	0.544
Carbohydrate intake (E%)	48.5 ± 5.5	46.2 ± 3.9	0.196
Fat intake (E%)	36.8 ± 4.7	38.2 ± 3.8	0.363
Saturated fat intake (E%)	14.0 ± 2.6	14.3 ± 2.1	0.732
Intake fibers (g/day)	17.8 ± 4.0	17.0 ± 5.0	0.623
Intake calcium (mg/day)	771 ± 296	686 ± 220	0.385
Intake Fe (mg/day)	10 ± 2	9 ± 2	0.171
Fruit (pieces/day)	0.8 ± 0.4	0.8 ± 0.7	0.995
Vegetables (g/day)	161 ± 54	132 ± 40	0.116
Total FA score	8.4 ± 1.4	8.9 ± 3.1	0.549

Recommendations for pregnancy care after bariatric surgery

- Start preconceptionally
- Multidisciplinary approach
- Patient-tailored



Preconception

- Delay pregnancy until after period of rapid weight loss (1 year minimum)
- Provide effective contraception
- Involve life-style coach
- Evaluate nutritional state, correct where necessary
- Evaluate most common deficiencies
- Supplement according to deficiencies
- Start folic acid (4mg)
- Advice rapid pregnancy test if sec amenorrhea

Booking

- Involve life-style coach
- Evaluate nutritional state, correct where necessary
- Evaluate most common deficiencies
- Supplement according to deficiencies (Fe, B12, vit K)
- Continue folic acid (4mg if obese) until 12 weeks
- Adjustable balloon: not systematically open, open if vomiting regularly (DD morning sickness)

Pregnancy

- Advice GWG according to IOM guidelines for preconception BMI
- Pay attention to symptoms of surgical complications
- Detailed morphologic scanning at 12-20-30 weeks
 - Attention for growth, ossification, ICH
- Screen for GDM
 - GCT-OGTT dumping very frequent (50-95%)
 - Fasting glucose
- Reevaluate nutrition-deficiencies every trimester

Postpartum

- Advice and support breast feeding ?
- Evaluate for signs of depression
- Advice life-long coaching of life-style

Conclusions

- Increasing number of obese pregnant women
- Treatment/coaching during pregnancy is disappointing
- Bariatric surgery is increasingly being used to treat morbid obesity in women of reproductive age
- General reproductive capacity and pregnancy outcome appears improved after bariatric pregnancy
- Specific fetal, maternal and obstetrical complications are more frequent after bariatric surgery
- A patient-tailored multidisciplinary approach is advisable

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