Analyzing long-term BMI change following gastric bypass surgery

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Obesity and overweight

- Obesity and overweight are conditions in which excess body fat accumulates.
- Both are associated with increased mortality
- Both are associated with increased incidence of many illnesses, including hypertension, diabetes, coronary heart disease, and stroke

How to classify overweight and obesity

- BMI = $\frac{weight(kg)}{height^2(m^2)}$
- Overweight : BMI ≥ 25.

  Obese: BMI ≥ 30.
- What BMI is not: an absolute indicator of healthy versus unhealthy weight
- What BMI is: a convenient and useful way to approximate body fat in an individual

Lebron James: Perennial NBA All Star

Height: 6’ 8” (203 cm)

Weight: 249 lbs (113 kg)

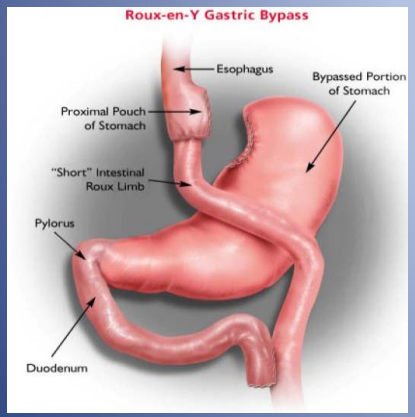
BMI: 27.4 kg/m²

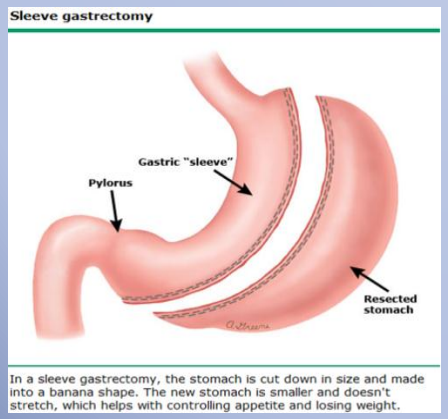
Obesity and overweight in the United States

- More than one-third of U.S. adults are obese, while two-thirds are overweight.
- Improving diet and exercising regularly are two ways to prevent excess fat accumulation.
- Bariatric surgery is most effective; refers to a variety of procedures in which part of the stomach is either removed or modified

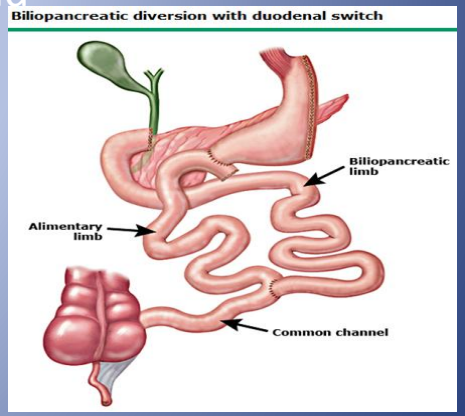
Types of Bariatric Surgery

- Four examples of bariatric surgery procedures are gastric bypass, sleeve gastrectomy, adjustable gastric band, and biliopancreatic diversion with duodenal switch

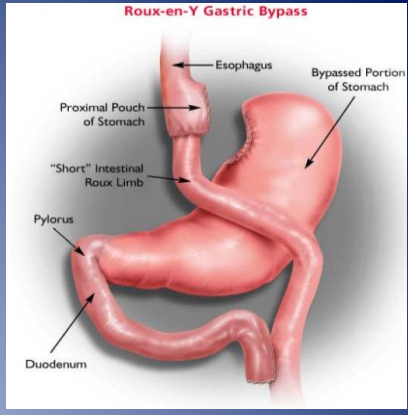




Adjustable Gastric Band



Our Research



- Our research focused on gastric bypass surgery (most common of all bariatric procedures)
- Looked at two outcomes after surgery:
  1. BMI change as a function of time after surgery
  2. Complications after surgery (in progress)

Methods

- We used data abstracted from the clinical records of Dr. Christopher Eagon, a bariatric surgeon here at WUSM, to form a retrospective cohort
- Data were abstracted into 3 excel files:
  1. Demographics
  2. BMI measurements (post-op and pre-op)
  3. Post-surgery complications

Let the SAS begin!

- The 3 excel files were converted into SAS data files using the *PROC IMPORT* statement
- *proc import*
- *datafile = "H:\bmi_data“;*
- *out = Nilslib.bmi_data;*
- *sheet = ‘sheet 1';*
- *run;*

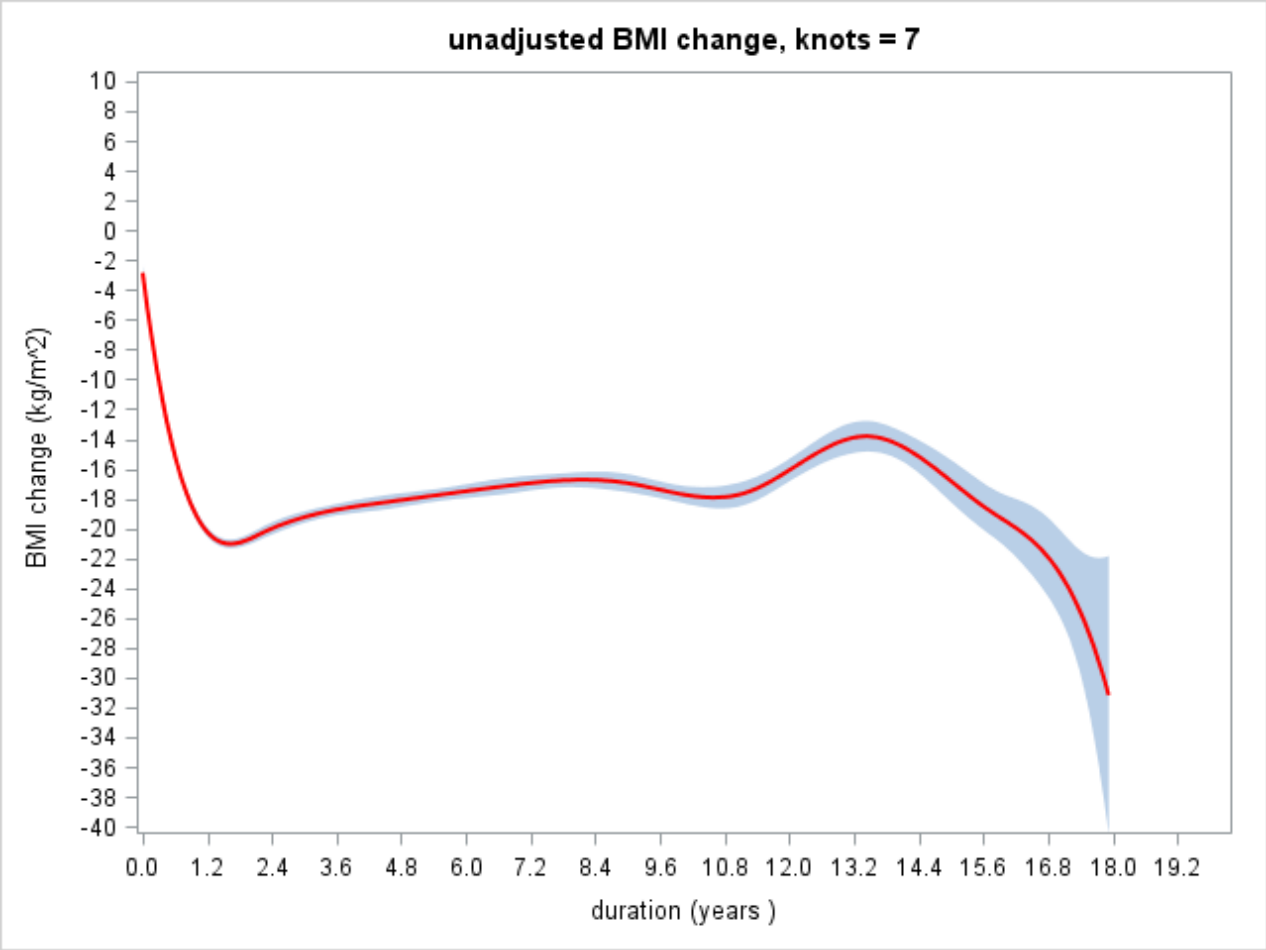
Merging of Data

- Next step was to merge the 3 files, now in SAS datefile format, into one to facilitate analysis
- Done using *DATA* step
- *data Nilslib.merged_data;*
- *merge Nilslib.bmi_data Nilslib.demographics_ data Nilslib.complications_data;*
- *by ID;*
- *run;*

Unadjusted Analysis

- File now ready for analysis.
- 1st step: unadjusted analysis. A B-spline polynomial fitting method was used to fit a curve to BMI change as a function of time after surgery
- ***proc sgplot*** *data=Nilslib.merged_data ;*
- *title “bmi_change, unadjusted ";*
- *yaxis VALUES=(**-40** to **10** by **5**) label=“bmi change";*
- *xaxis VALUES=(**0** to **20** by **0.2**) label="duration after surgery";*
- *pbspline x=duration y=bmi change/NKNOTS=**7** nomarkers LINEATTRS=(COLOR=red PATTERN=**1** THICKNESS=**2**)*
- *clm="95% CLM" ;*
- ***run**;*

Unadjusted Analysis



BMI Loss Example

Height: 5’ 9” (175 cm)

Weight: 325 lbs (147 kg)

BMI: 48 kg/m²

ΔBMI = 21 kg/m²

Δ Weight = 145 lbs (66 kg)

Height: 5’ 9” (175 cm)

Weight: 180 lbs (82 kg)

BMI: 27 kg/m²

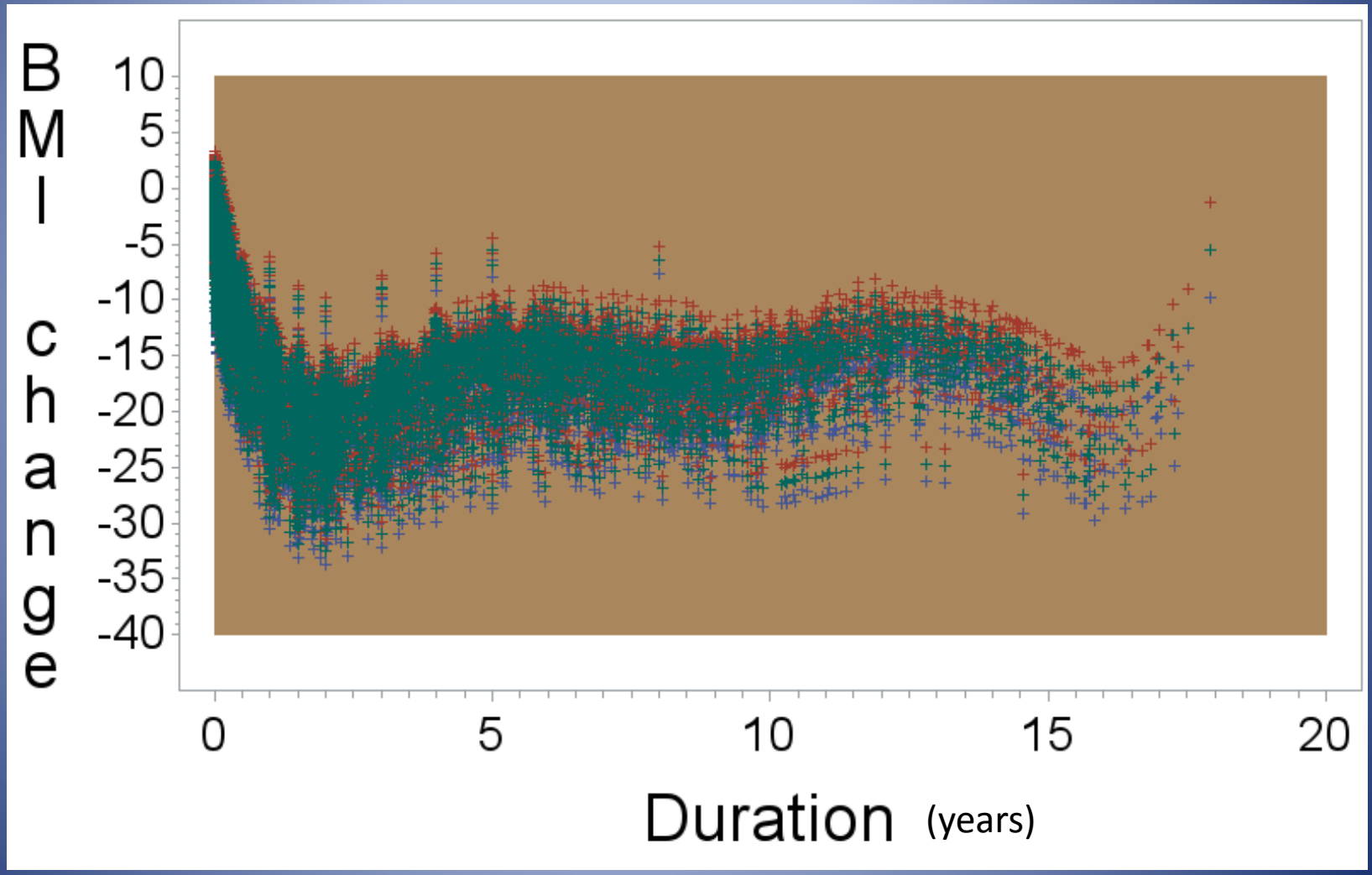
Multivariable Adjusted Analysis

- Following unadjusted analysis, a linear mixed model was fit to the data
- Mixed model: one that takes into account the correlation between multiple measurements for the *same* individual
- *proc mixed data = Nilslib.merged_data noclprint covtest noitprint ord;*
- *class ID duration_cat primary_insurance (ref = "Private Insurance") sex race;*
- *model bmi_change = AGE pre_surg_bmi duration_cat primary_insurance sex race duration Duration_2 duration_3 duration_4 duration_5 duration_6 /solution ddfm = bw outpm = Nilslib.predicted;*
- *random intercept Duration / subject = ID type = un;*
- *run;*

Results

Covariate	Estimate	P-value	Covariate	Estimate	P-value
Age	0.03	0.02	**Sex**		
Pre-surg BMI	-0.27	<.0001	Female	-0.30	0.32
Pre- Surgery BMI Measurement Date			Male (reference)	0.00	.
BMI Measured >90 days pre-op	-0.35	0.30	**Race**		
BMI Measured 30-90 days pre-op	0.31	0.37	Hispanic	1.57	0.37
BMI Measured <30 days pre-op (reference)	0.00	.	African-American	1.32	0.00
Primary Insurance			Caucasian (reference)	0.00	.
Medicaid	-0.17	0.75	**Duration**	-24.08	<.0001
Medicare	0.74	0.01	**Duration^2**	11.30	<.0001
Other Government	-0.31	0.62	**Duration^3**	-2.29	<.0001
Self Pay	0.65	0.49	**Duration^4**	0.23	<.0001
Private Insurance (reference)	0.00	.	**Duration^5**	-0.01	<.0001
			Duration^6	0.00	<.0001

Predicting BMI Change After Surgery



BMI Change Analysis

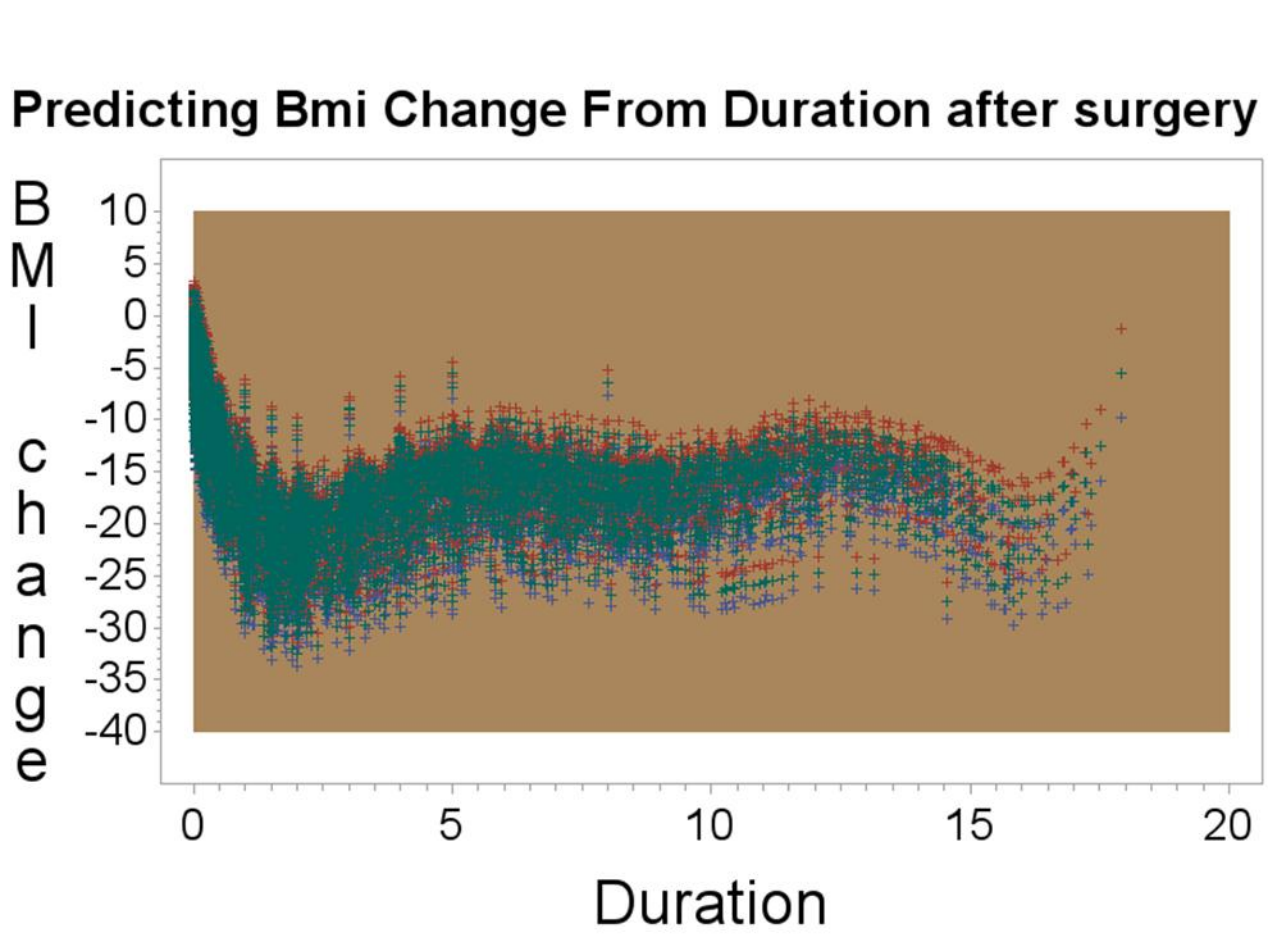
- We used PROC GPLOT to plot the predicted BMI change generated from the estimates in the linear mixed model
- First define axes:
- *axis1 label=(height=**3.5** angle=-**90** rotate=**90** 'BMI change') order=(-**40** to **10** by **5**) value=(height=**2.5**) offset=(**3**);*

- *axis2 label=(height=**3.5** 'Duration (years)'), order=(**0** to **20** by **5**) value=(height=**2.5**) offset=(**3**);*

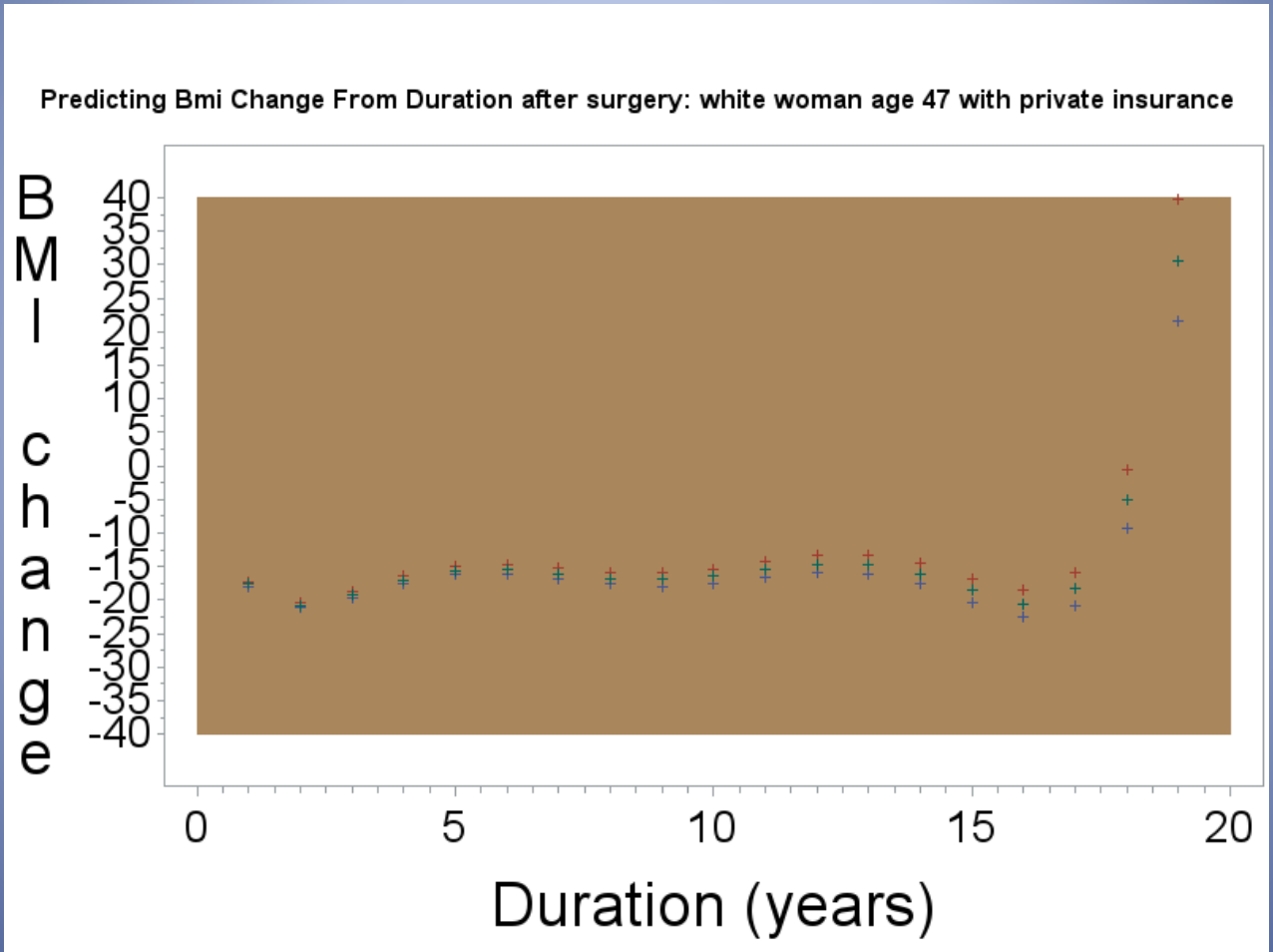
BMI Change Analysis

- Now we use PROC GPLOT
- ***proc gplot*** *data=Nilslib.predicted;*
- *plot lower*duration upper*duration pred*duration/ areas =* ***4*** *overlay vaxis=axis1*
- *haxis=axis2 ;*
- *title2 h=****4*** *'Predicting Bmi Change From Duration after surgery';*
- ***run****;*

Predicting BMI Change After Surgery: entire cohort



Predicting BMI change after surgery: sample person



Conclusions

- Gastric bypass surgery is an effective way to treat obesity
- The long follow-up times present in this data set allow us to observe noticeable and *persistent* BMI loss after surgery
- Limitation: thinning of data after ~12 years post surgery

Next Steps

- Analyzing complications after bariatric surgery
- Analyzing remission/improvement of comorbidities after surgery

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