Importance of physical activity before and after bariatric surgery in patients with type 2 diabetes

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1. Moderate-intensity aerobic physical activity for at least 150 min.wk\(^{-1}\); Lasting >30 min on 5+ days.

2. Exercise can be accumulated across multiple bouts throughout the week. Individual bouts >10 min of moderate intensity activity at a time.

3. Vigorous-intensity activity also provides health benefits for adults, 75 min.wk\(^{-1}\) provides comparable benefits to 150 min.wk\(^{-1}\) of moderate-intensity activity.

4. Combinations of moderate- and vigorous- intensity activities possible

5. Muscle strengthening activities involving the major muscle groups of the body on 2+ days per week in addition to 150 min.wk\(^{-1}\) moderate-intensity activity.

6. No need to differ for sub-populations based on gender or race/ethnicity.
Two-thirds of Bariatric Surgery patients found to have walking limitations

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Reduced functional mobility, cardio-respiratory and strength responses in patients awaiting metabolic surgery
Evidence of Pre-Surgical Physical activity on clinical markers is poor but advocated

- **Mild** exercise (including **aerobic conditioning** and light **resistance training**) for 20 minutes a day on 3 to 4 days a week (?) before surgery.

- ‘Pre-surgery PA engagement may improve cardiorespiratory fitness, reduce the risk of surgical complications, facilitate healing and enhance postoperative recovery’

*American Society for Metabolic and Bariatric Surgery (ASMBS 2012)*
CPX variables relate to Length of stay following Bariatric Surgery

Physical Activity Levels of Patients Undergoing Bariatric Surgery

Longitudinal Assessment of Bariatric Surgery (LABS)

- LABS a longitudinal observational study designed to assess the risks and benefits of bariatric surgery. Patients at least 18 years old seeking their first bariatric surgery by participating surgeons at six clinical US sites.
- Participants wore an accelerometer and completed a physical activity diary.
- The most commonly reported activities were:
  - 44% walking
  - 11% gardening
  - 10% playing with children
  - 7% stretching


<table>
<thead>
<tr>
<th>Activity Category</th>
<th>%</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary (&lt;5000 steps.d⁻¹)</td>
<td>20</td>
<td>151</td>
</tr>
<tr>
<td>Low active (5000-7499 steps.d⁻¹)</td>
<td>33.9</td>
<td>256</td>
</tr>
<tr>
<td>Somewhat active (7500-9999 steps.d⁻¹)</td>
<td>26.6</td>
<td>201</td>
</tr>
<tr>
<td>Active (10000-12499 steps.d⁻¹)</td>
<td>13.5</td>
<td>102</td>
</tr>
<tr>
<td>Highly Active (≥12500 steps.d⁻¹)</td>
<td>6.1</td>
<td>46</td>
</tr>
</tbody>
</table>
Increasing PA preoperatively improves physical activity & mental HRQoL in bariatric surgery candidates

**Bari-Active Trial: Pre-Surgery ‘Prehabilitation’**

n=75 adult participants (86.7% female; BMI = 45.0 ± 6.5 kg m⁻²) randomly assigned to 6 weeks of exercise pre-habilitation (n = 40) or standard pre-surgical care (Con; n = 35).

PAI received 6 individual weekly counselling sessions to increase walking exercise. Participants wore an PA monitor (7 days) and completed the SF-36 Health Survey at baseline and post-intervention to evaluate HRQoL.

PAI reported greater improvements than Con on all SF-36 physical and mental scales (P < 0.05) - except role-emotional.

Evidence of Pre-Surgical Physical activity on clinical markers is poor but advocated

- **Mild** exercise (including *aerobic* conditioning and light *resistance* training) for 20 minutes a day on 3 to 4 days a week (?) before surgery.

- ‘Pre-surgery PA engagement may improve cardiorespiratory fitness, reduce the risk of surgical complications, facilitate healing and enhance postoperative recovery’


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**Pre-Surgery Exercise Programme (4 mo twice weekly x 25 min session)**

Functional capacity and cardio-metabolic parameters significantly improved in the intervention arms and worsened in the control group.

Exercise adherence was above 78%.

<table>
<thead>
<tr>
<th>N=66</th>
<th>Δmass (kg)</th>
<th>ΔBMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>-7.4 kg (-9.6 to 5.1)</td>
<td>-2.7 (-3.6 to -1.8)</td>
</tr>
<tr>
<td>Exercise + CBT</td>
<td>-4.2 (-6.8 to -1.6)</td>
<td>-1.4 (-2.4 to -0.4)</td>
</tr>
<tr>
<td>Typical Pre Surgery care</td>
<td>2.9 (0.4 to 5.3)</td>
<td>1.1 (0.1 to 2.1)</td>
</tr>
</tbody>
</table>
Pre-operative PA level related to post-surgery PA level

<table>
<thead>
<tr>
<th></th>
<th>Pre-Operative</th>
<th>1-year post op</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>Steps per day</td>
<td>Median IQR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7563(5570,9575)</td>
<td>8788(6655,11149)</td>
<td>1457(-276,2822)</td>
</tr>
<tr>
<td></td>
<td>1552-21349</td>
<td>1502-24121</td>
<td>-7648-17205</td>
</tr>
<tr>
<td>Active min per day</td>
<td>Median IQR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>309(245,380)</td>
<td>340(276,413)</td>
<td>31(-27-330)</td>
</tr>
<tr>
<td></td>
<td>74-559</td>
<td>88-679</td>
<td></td>
</tr>
<tr>
<td>High cadence min/wk-1</td>
<td>Median IQR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>72(34,130)</td>
<td>112(50,185)</td>
<td>23(-8,72)</td>
</tr>
<tr>
<td></td>
<td>0-816</td>
<td>0-977</td>
<td>-343-680</td>
</tr>
<tr>
<td>High cadence min in bouts of &gt;10 min/wk-1</td>
<td>Median IQR</td>
<td>2-3(0,76)</td>
<td>1(0,50)</td>
</tr>
<tr>
<td></td>
<td>0(0,26)</td>
<td>0-680</td>
<td>-294-680</td>
</tr>
<tr>
<td></td>
<td>0-450</td>
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<td></td>
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</tbody>
</table>

More preoperative PA predicted for more PA postoperatively (P < .001) related to...

- Less pain,
- No asthma,
- Self-report of increasing PA as a pre-op weight loss strategy

- However ¼ of participants were less active post-op vs. pre-op.

Post-operative exercise

‘Exercise after surgery is imperative, and may be the most important factor that can achieve long-standing and successful weight loss’.

1. Start walking from day 1.

2. Increase your walking each day. Add other aerobic exercises like swimming and bicycle riding as your surgeon permits and as you feel so inclined.

3. Start light weight training and sit-ups as your surgeon allows. Increase weights and number of reps gradually. This type of exercise will increase muscles mass which improves strength, increases bone density, and increases metabolism.

4. Consider using a personal trainer to educate one about exercise, improve motivation, and help assure proper routines.

American Society for Metabolic and Bariatric Surgery (ASMBS) 2012
General Advice for post-surgery physical activity programme

• R86. Increase their physical activity (aerobic and strength training) to a minimum of 30 min per day as well as increase physical activity throughout the day as tolerated (Grade D).


• Only 22% of patients in American College of Surgeons Bariatric Surgery Centre Network accredited centres received post-surgery exercise consultations despite BSCN accreditation requiring exercise counselling

Effects of Physical Activity following Bariatric surgery

1. Weight: Loss vs. Regain
2. Metabolic control (insulin, glucose)
3. Functional capacity: VO$_2$, PA, CVD risk factors
4. Psychology changes: QoL, readiness to exercise
Weight Loss

- Bariatric surgery induces weight loss but is not an infallible treatment. 10–30% of bariatric patients experience suboptimal weight loss and long term effectiveness is less clear.

- Exercise may be an important adjunct therapy


- Excess weight loss was improved at 12 months but not 36 months postoperatively by attending semi-structured exercise education classes Rothwell et al. Obes Surg 2015; 25: 126–128.
Lifestyle intervention following bariatric surgery is feasible and results in beneficial outcomes

N=8 female patients (44±8 yo, BMI = 38.5±7.2 kg.m⁻²) completed 8-week combined supervised exercise with nutritional-behavioural intervention following RYGB and SG. Percentage weight loss compared with historical matched controls...

- Increased strenuous intensity exercise (44 ± 49 min/week, p = 0.043)
- Increased consumption of fruits and vegetables (p = 0.034)
- Reduced consumption of ready meals (p = 0.034)
- Improved "Change in Health" in QoL domain (p = 0.039)

The intervention group exhibited greater weight loss in the 3-12-month post-surgery period compared to historical controls, **12.2 ± 7.5% versus 5.1 ± 5.4%**, respectively (p = 0.027).

..worryingly loss of lean tissue is an issue


• 12–18 months after weight loss surgery, 33–50% of initial weight loss may be regained (Wing RR., 2002; 301–316.)

• Moderate-intensity exercise is critical for maintaining weight loss (National Weight Control Registry (NWCR) [Ann Rev Nutr 2001; 21: 323–341.]

• For example, addition of 275 min.wk⁻¹ of physical activity in combination with a reduction in energy intake was necessary for maintenance of a 10% weight loss in obese women. (Shah M, et al. 2011 Obesity. 19(9):1826-34).

• However, still a lack of longer term evidence in bariatric surgery patients. Herman et al., 2014
Metabolic Control

Bariatric surgery rapidly improves glycaemic control and insulin sensitivity.

Caloric restriction improves hepatic insulin sensitivity
HOMA-IR, & hyperinsulinaemic-euglycaemic clamp with stable isotopic tracer) after RYGB surgery


But…. 1 month after RYGB surgery peripheral tissue insulin sensitivity did not change despite 11% weight loss


Exercise may be beneficial to improve peripheral tissue insulin sensitivity after surgery-induced weight loss.

Prior exercise improves insulin sensitivity of glucose uptake in the exercised compared with the rested leg in healthy human subjects as indicated by the reduction in insulin concentration eliciting half maximal glucose uptake response (glucose uptake is given as % of maximal increase) based on data extracted from Richter et al. (1989).
RYGB patients after regular supervised exercise (6mo) improve insulin sensitivity (SI) more than surgery alone.

Skeletal muscle glucose uptake is increased by exercise independent and dependent mechanisms.

**Exercise** leads to an increase in fat (FFA) and glycerol levels. These substances act as signaling molecules to the muscle cell.

**Intracellular mechanisms** include the activation of enzymes like IRS, PI3K, PDK1, PKC, Akt, and AS160, which ultimately result in the increased expression of GLUT4. GLUT4 then facilitates the uptake of glucose into the muscle cell.

**Fatty acid oxidation** is also increased, leading to higher levels of acyl-CoA and free fatty acids (FFA). This process is mediated by enzymes such as CAT-1, which facilitate the transport of fatty acids into the cell.

**Glycogen synthesis** and **glucose transport** are enhanced, allowing for a better utilization of glucose by the muscle cell during exercise.
Ceramide content in muscle decreases with RYGB surgery–induced weight loss.
Dose-Response of Exercise Training following RYGB surgery

Post-hoc analysis of participants, randomized into either a 6-month structured exercise program or a health education control (CON). EX(N=56) were divided into tertiles according to the amount of weekly exercise performed, compared to CON(N=42): Low-EX=54±8; Middle-EX=129±4; High-EX=286±40 minutes per week.

Woodlief et al., 2015. Obesity Dec;23(12):2454-61.
Dose-Response of Exercise Training following RYGB surgery

Woodlief et al., 2015. Obesity Dec;23(12):2454-61.
Possible mechanisms by which exercise following RYGB surgery may confer additional metabolic benefits.

Obesity + RYGB = Weight Loss

Exercise = Mitochondrial function + ↓ Muscle Lipids

Improved insulin sensitivity


• Dose dependent effects: CON (n = 42): low-EX = 54±8; middle-EX 129±4 high-EX 286 ± 40 min.wk⁻¹. High-EX lost more body weight, fat mass & abdominal fat compared with CON (P < 0.005). Physical fitness (VO₂ max) improved in high-EX (9.3% ± 4.2%) compared with CON (-6.0 ± 2.4%, P<0.001). Woodlief et al., (2015) Obesity. 23(12):2454-61.

Functional Capacity
Improvements in some health-related QoL

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group (n = 8)</th>
<th>High-volume exercise group (n = 20)</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>6 weeks</td>
<td>12 weeks</td>
</tr>
<tr>
<td></td>
<td>63 ± 23</td>
<td>71 ± 20</td>
<td>75 ± 17</td>
</tr>
<tr>
<td>Physical function</td>
<td>68 ± 21</td>
<td>75 ± 18</td>
<td>80 ± 20*</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>50 ± 30</td>
<td>67 ± 30</td>
<td>63 ± 27**</td>
</tr>
<tr>
<td>Sexual life</td>
<td>59 ± 24</td>
<td>70 ± 24</td>
<td>80 ± 22***</td>
</tr>
<tr>
<td>Public distress</td>
<td>67 ± 32</td>
<td>86 ± 21</td>
<td>81 ± 20*</td>
</tr>
<tr>
<td>Work or daily activities</td>
<td>68 ± 30</td>
<td>80 ± 26</td>
<td>84 ± 21*</td>
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<tr>
<td>Total score</td>
<td>65 ± 31</td>
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<td>79 ± 19</td>
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<td>68 ± 28</td>
<td>77 ± 24</td>
<td>87 ± 18**</td>
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<td></td>
<td>68 ± 25</td>
<td>83 ± 17</td>
<td>85 ± 27*</td>
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<td>78 ± 28</td>
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<td>75 ± 19*</td>
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<td>67 ± 18</td>
<td>76 ± 16</td>
<td>83 ± 16***</td>
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<tr>
<td>SF-36</td>
<td>48 ± 5</td>
<td>50 ± 5</td>
<td>50 ± 8</td>
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<td>Physical functioning</td>
<td>49 ± 9</td>
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<td>52 ± 7</td>
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<tr>
<td>Role limitation physical</td>
<td>52 ± 6</td>
<td>54 ± 3</td>
<td>54 ± 4</td>
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<td>Bodily pain</td>
<td>51 ± 10</td>
<td>51 ± 7</td>
<td>53 ± 6</td>
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<td>General health</td>
<td>48 ± 10</td>
<td>51 ± 11</td>
<td>54 ± 8</td>
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<tr>
<td>Emotional well being</td>
<td>52 ± 9</td>
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<td>52 ± 7</td>
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<tr>
<td>Role limitation emotional</td>
<td>50 ± 8</td>
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<td>50 ± 7</td>
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<tr>
<td>Social functioning</td>
<td>51 ± 8</td>
<td>51 ± 6</td>
<td>51 ± 8</td>
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<tr>
<td>Energy</td>
<td>47 ± 11</td>
<td>54 ± 8</td>
<td>57 ± 7**</td>
</tr>
<tr>
<td>Physical QOL summation</td>
<td>49 ± 9</td>
<td>55 ± 11</td>
<td>54 ± 13</td>
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<tr>
<td>Mental QOL summation</td>
<td>52 ± 9</td>
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<td>45 ± 12</td>
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<td>46 ± 10</td>
<td>55 ± 8</td>
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<td>53 ± 8</td>
<td>55 ± 7**</td>
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</tbody>
</table>

Values are means ± SD. The group-by-time interaction was evaluated by repeated measures analysis. 
IWQOL-L, Impact of Weight on QOL-Lite; QOL, quality of life; SF-36, Short-Form 36. 
*P < 0.05 for within-group change over 12 weeks. **P < 0.01 for within-group change over 12 weeks. ***P < 0.001 for within-group change over 12 weeks.
Bariatric surgical patients decreased sedentary behaviour & increased PA over 1 year post-surgery and maintain it by 3 years. Post-surgery PA still falls short of CMO guidelines for general health or weight control.

Percent of participants achieving ≥150 min/wk of bout-related MVPA was LOW and not different at year 3 [6.5% (95%CI: 3.1–12.7)] vs. pre-surgery [3.4% (95%CI: 1.8–5.0); p=.45].

King et al., 2015, Obesity 23(6) 1143-1150.
so what should I tell my patients?

1. Get **More active**: something is better than nothing! Noting precautions & pre-Screening

2. **Start modestly**: progress from *Easy* to *Moderate*...

3. Frequency **5+ days per week** (part of your lifestyle - not squeezed in when feasible)

4. Mode: daily activities, aerobic and resistance: **diversity**

5. **Build motivation** that leads to a change in behaviour in and out of work.
Help is at hand for healthcare professionals in need of physical education for Chronic Conditions management
Thank you for your attention