Is exercise an effective strategy for preventing weight gain in adults?: trial evidence

Robert Ross
PhD, R. Kin, FACSM, FAHA
School of Kinesiology and Health Studies
Medicine, Division of Endocrinology and Metabolism
Queen’s University
Kingston, Ontario, Canada
Is exercise an effective strategy for preventing weight gain in adults?

To clarify the question.

What happens when adults exercise / increase physical activity?

What happens when adults are encouraged to exercise / increase physical activity?
Two Types of Randomized Controlled Trials

Efficacy Studies
- Explanatory (cause and effect)

Effectiveness Studies
- Pragmatic – more implementation and generalizability questions

What happens when you increase PA?
- Trials primary concerned with physiological response?

What happens when you are encouraged to increase PA?
- Trials primarily concerned with changing behavior
Is exercise an effective strategy for preventing weight gain in adults?

What happens when adults exercise / increase physical activity?

What happens when adults are encouraged to exercise / increase physical activity?
Effects of Diet or Exercise with or Without Weight Loss on Body Weight

![Graphs showing weekly weight loss over 12 weeks for men and women.](image)

- **Control**
- **Diet Weight Loss**
- **Exercise Weight Loss**
- **Exercise Without Weight Loss**

**MEN**

**WOMEN**


Effects of Exercise (4 mo) With or Without Weight Loss on Waist Circumference in Obese Men and Women

* p<0.05 vs Control

Obese Women

Exercise-induced energy expenditure (exercise) averaged 500 kcal / per day / 4 months: 60 minutes

Consumed about 500-600 additional calories per day to try an offset the negative energy balance induced by daily exercise to maintain weight

Ross et al. Obesity Research 2004
Effects of amount and intensity of exercise on blood lipids

*Kraus W. et al  NEJM 347: 1483, 2002*

LALI = low amount, moderate intensity
LAHI = low amount, high intensity
HAHI = high amount, high intensity

Change in Body Weight (kg)

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LAMI</th>
<th>LAHI</th>
<th>HAHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>LALI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

...“subjects were counseled to maintain body weight...[eat more]...”

Exercise (6 mo)

<table>
<thead>
<tr>
<th></th>
<th>LAMI</th>
<th>LAHI</th>
<th>HAHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles / wk</td>
<td>11</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Min / wk</td>
<td>176</td>
<td>117</td>
<td>174</td>
</tr>
</tbody>
</table>
Effects of exercise amount and intensity on abdominal obesity and glucose tolerance in 300 obese adults

Treatment

1. Wait List Control
2. 180(F) / 300(M) kcal / session @ 50% of VO$_2$ peak (~ 30 min) LALI
3. 360(F) / 600(M) kcal / session @ 50% of VO$_2$ peak (~ 60 min) HALI
4. 360(F) / 600(M) kcal / session @ 75% of VO$_2$ peak (~ 35 min) HAHI

Random Allocation

All participants exercise 5d/wk for 6 months under supervision

All participants received personalized diet counseling – asked to maintain baseline energy intake (eat no more) throughout intervention.

## Participant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LALI</th>
<th>HALI</th>
<th>HAHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size (N)</td>
<td>75</td>
<td>73</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Age (years)</td>
<td>52.2 ± 8.2</td>
<td>52.1 ± 7.4</td>
<td>50.9 ± 8.6</td>
<td>50.3 ± 8.1</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>33.1 ± 4.6</td>
<td>33.7 ± 4.4</td>
<td>33.5 ± 4.9</td>
<td>33.4 ± 4.3</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>109.5 ± 10.5</td>
<td>110.7 ± 11.3</td>
<td>111.1 ± 11.2</td>
<td>111.3 ± 12.1</td>
</tr>
<tr>
<td>VO₂ peak (ml/kg/min)</td>
<td>28.5 ± 5.9</td>
<td>28.1 ± 5.4</td>
<td>28.3 ± 4.8</td>
<td>28.1 ± 5.6</td>
</tr>
</tbody>
</table>
Trial Design

24 week intervention
VO2 peak tests
Baseline Week 24
Week 16
Week 4
Week 8
Week 24
Accelerometry
Change in Waist Circumference

Values are least-squares estimated means adjusted for age and sex

LALI = low amount, low intensity
HALI = high amount, low intensity
HAHI = high amount, high intensity

* different from Control
Change in Body Weight at 24 Weeks

LALI = low amount, low intensity
HALI = high amount, low intensity
HAHI = high amount, high intensity

* different from Control

<table>
<thead>
<tr>
<th>Weight Loss (kg)</th>
<th>LALI</th>
<th>HALI</th>
<th>HAHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 min/session</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58 min/session</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 min/session</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* * *
### Daily Unstructured Physical Activity

<table>
<thead>
<tr>
<th>Group</th>
<th>Change in Unstructured Physical Activity at 24 weeks (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (n= 75)</td>
<td>-2 (-23 to 21)</td>
</tr>
<tr>
<td>LALI (n= 73)</td>
<td>-3 (-24 to 18)</td>
</tr>
<tr>
<td>HALI (n= 76)</td>
<td>4 (-15 to 24)</td>
</tr>
<tr>
<td>HAHI (n= 76)</td>
<td>11 (-11 to 33)</td>
</tr>
</tbody>
</table>
Is exercise an effective strategy for preventing weight gain in adults?

What happens when adults exercise / increase physical activity?  

Efficacy RCTs

Without compensation (eat no more) in caloric intake – weight loss

With compensation in caloric intake – prevention of weight gain

These observations in response to exercise consistent with consensus guidelines
Is exercise an effective strategy for preventing weight gain in adults?

What happens when adults exercise?  **Efficacy**

What happens when adults are asked to exercise?  **Effectiveness**
A systematic review of interventions aimed at the prevention of weight gain in adults


Five databases searched to July 2008

**Nine RCTs** : individuals (7 studies), families (1 study), schools (1 study)

Intervention length varied from 13 weeks to 5 years

3 interventions were ≤ 16 weeks, 2 interventions = 1 year, 2 interventions = 2 years
1 intervention = 3 years and 1 intervention = 5 years

Overall, interventions included 375 men and 1595 women

All interventions included diet and physical activity with behaviour change strategies
A systematic review of interventions aimed at the prevention of weight gain in adults

Five studies reported a significant difference between treatment and control between 1.0 and 3.5kg. Largely due to increase in body weight within controls

Not possible to identify successful components of intervention.

More intensive interventions were not always successful

Interventions that included mixed modes of delivery with some personal contact were successful.

Authors: further large, effective evidence-based programs are urgently required.
Prevention of weight gain in young adults through a seminar-based intervention program

- Participants: 150 healthy, non-obese freshmen medical students
- Intervention: 23 seminars on physical activity, diet, and behaviour
- Duration: 24 months
• Weight change: 1.3 kg between groups

• Secondary findings: No difference in fitness, physical activity, or caloric intake between groups
  • Plasma triglycerides increased in the control group, decreased in the intervention group
Weight Gain Prevention among Women

- Participants: 284 healthy women, BMI < 30
- Intervention: 3 groups: clinic-based (15 visits + individual counselling if weight gain occurred), correspondence course (15 lessons), information-only control (received written information)
- Participants given goals for diet and exercise
- Duration: 2 years with 1 year follow-up
Primary Findings

- Weight Change: no significant difference between all groups
  - Trend towards weight gain in control
  - Small weight loss in clinic group

- Secondary Findings: Weight maintenance was associated with increased dietary restraint (conscious thoughts and purposeful behaviour to control intake) and decreased dietary disinhibition (tendency to lose control over eating) over time
Women’s Healthy Lifestyle Project: A Randomized Clinical Trial


- Participants: 535 peri- to postmenopausal women

- Intervention: Intensive sessions for the first 20 weeks, then 1-2 meetings/month for 5 years
  - Objective: keep weight below baseline, encouraged modest weight loss initially
  - Refresher programs offered, cooking classes, group walks, dance classes, incentives and group competitions
  - Individual and group sessions with a psychologist available for those lapsing or gaining weight

- Duration: 54 months
Primary Findings

- Weight change: Intervention = -0.1 kg, control gained 2.4 kg
- Secondary findings: LDL increased significantly more in assessment group (8.9 mg/dL) vs intervention (3.5 mg/dL)
  - Triglycerides and glucose also increased significantly more in the assessment group vs. intervention
Aim: To estimate effects of lifestyle on bodyweight and other cardiometabolic variables in adults with psychotic disorders

Conclusion: Effect sizes for weight gain prevention interventions were large (-0.84 (CI: -1.28 to -0.4kg)) and the effects of the weight loss interventions moderate.
(a) Weight loss intervention studies

All trials prescribed diet and exercise programs, included CBT
Unable to identify component of intervention contributing to weight gain prevention
In general the trial quality was poor

(b) Weight gain prevention intervention studies

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Std. Mean Difference</th>
<th>SE</th>
<th>Intervention Total</th>
<th>Control Total</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poulin 2007</td>
<td>-1.86</td>
<td>0.2299</td>
<td>59</td>
<td>51</td>
<td>14.5%</td>
<td>-1.86 [-2.31, -1.41]</td>
<td></td>
</tr>
<tr>
<td>Evans 2005</td>
<td>-1.25</td>
<td>0.3323</td>
<td>22</td>
<td>22</td>
<td>12.4%</td>
<td>-1.25 [-1.90, -0.60]</td>
<td></td>
</tr>
<tr>
<td>Jean-Baptiste 2007</td>
<td>-1.0532</td>
<td>0.461</td>
<td>11</td>
<td>11</td>
<td>9.9%</td>
<td>-1.05 [-1.96, -0.15]</td>
<td></td>
</tr>
<tr>
<td>Kwon 2006</td>
<td>-0.76</td>
<td>0.3218</td>
<td>33</td>
<td>15</td>
<td>12.6%</td>
<td>-0.76 [-1.39, -0.13]</td>
<td></td>
</tr>
<tr>
<td>Littrell 2003</td>
<td>-0.695</td>
<td>0.2466</td>
<td>35</td>
<td>36</td>
<td>14.2%</td>
<td>-0.69 [-1.18, -0.21]</td>
<td></td>
</tr>
<tr>
<td>Alvarez-Jimenez 2006</td>
<td>-0.6708</td>
<td>0.2645</td>
<td>28</td>
<td>33</td>
<td>13.8%</td>
<td>-0.67 [-1.19, -0.15]</td>
<td></td>
</tr>
<tr>
<td>Milano 2007</td>
<td>-0.1947</td>
<td>0.3334</td>
<td>22</td>
<td>14</td>
<td>12.4%</td>
<td>-0.19 [-0.85, 0.46]</td>
<td></td>
</tr>
<tr>
<td>Scocco 2006</td>
<td>0.0365</td>
<td>0.4495</td>
<td>10</td>
<td>10</td>
<td>10.1%</td>
<td>0.04 [-0.84, 0.92]</td>
<td></td>
</tr>
</tbody>
</table>

Total (95% CI) 220 191 100.0% -0.84 [-1.28, -0.40]

Heterogeneity: Tau² = 0.30; Chi² = 29.00, df = 7 (P = 0.0001); I² = 78%
Test for overall effect: Z = 3.72 (P = 0.0002)
The birth of ‘small changes’

Jim Hill, Science 2003
A Family-Based Approach to Preventing Excessive Weight Gain


- Participants: 105 parents with overweight children
- Intervention: Intervention group (82 families), control group (23 families)
  - Two aims for the intervention group: to increase steps (2000) and increase daily cereal intake (2 servings)
  - Both control and intervention were given pedometers, both required to keep daily food records
- Duration: 13 weeks
A Family-Based Approach to Preventing Excessive Weight Gain


![Average Steps Per day](chart)

Table 3. Cereal consumption

<table>
<thead>
<tr>
<th></th>
<th>EXP</th>
<th></th>
<th>CON</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Servings/wk</td>
<td>Servings/d</td>
<td>Servings/wk</td>
<td>Servings/d</td>
</tr>
<tr>
<td>Parents</td>
<td>7.31 ± 0.04*</td>
<td>1.04*</td>
<td>3.8 ± 0.14</td>
<td>0.54</td>
</tr>
<tr>
<td>Target children</td>
<td>8.10 ± 0.17*</td>
<td>1.16*</td>
<td>3.62 ± 0.17</td>
<td>0.52</td>
</tr>
<tr>
<td>Other children</td>
<td>7.2 ± 0.07*</td>
<td>1.03*</td>
<td>4.2 ± 0.51</td>
<td>0.60</td>
</tr>
</tbody>
</table>
A Family-Based Approach to Preventing Excessive Weight Gain


<table>
<thead>
<tr>
<th>Table 4</th>
<th>Differences in body weight/adiposity outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean change pre- to post-study</td>
</tr>
<tr>
<td></td>
<td>EXP</td>
</tr>
<tr>
<td>Target Children</td>
<td>Weight (kg)</td>
</tr>
<tr>
<td></td>
<td>% BMI</td>
</tr>
<tr>
<td></td>
<td>% Body Fat</td>
</tr>
<tr>
<td>Parents</td>
<td>Weight (kg)</td>
</tr>
<tr>
<td></td>
<td>% BMI</td>
</tr>
<tr>
<td></td>
<td>% Body Fat</td>
</tr>
<tr>
<td>Other Children</td>
<td>Weight (kg)</td>
</tr>
<tr>
<td></td>
<td>% BMI</td>
</tr>
<tr>
<td></td>
<td>% Body Fat</td>
</tr>
</tbody>
</table>

EXP, experimental; CON, control.
Encouraging a small change approach to sustain healthy behaviors and prevent weight gain

Subject Recruitment → Random Allocation

Treatment

1. Small Change Intervention Group (N=177)
2. Usual Care Group (N=177)
Study Design

Recruit

Consent

Pre-testing

~ 2 weeks

24 months of trial

12 months Follow-up

SCA: Small Change Approach

C: Normal Lifestyle
### SCA Counselling Sessions Overview

**SCA Group will attend counselling sessions with Behavioral Interventionist:**

- Provide feedback about small changes
- “Check-Ins” to address individual concerns
- Develop strategies for change
- Skill building
- Goal setting
- Review progress
- On-going maintenance

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Group Sessions</th>
<th>Check-ins</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 Months</td>
<td>9</td>
<td>3</td>
<td>~ 10.5 hours</td>
</tr>
<tr>
<td>7-12 Months</td>
<td>5</td>
<td>1</td>
<td>~ 5.5 hours</td>
</tr>
<tr>
<td>13-24 Months</td>
<td>4</td>
<td>4</td>
<td>~ 6 hours</td>
</tr>
<tr>
<td>25-36 Months</td>
<td>No counselling</td>
<td>(maintenance)</td>
<td></td>
</tr>
</tbody>
</table>
Primary Outcomes

Body Weight

Waist Circumference
SUMMARY
Is exercise an effective strategy for preventing weight gain in adults?

What happens when adults exercise / increase physical activity?  **Efficacy RCTs**

- Without compensation (eat no more) in caloric intake – weight loss
- With compensation in caloric intake – prevention of weight gain
Is exercise an effective strategy for preventing weight gain in adults?

What happens when adults are encouraged to exercise / increase physical activity?

Existing evidence suggests that lifestyle interventions designed to prevent weight gain are generally effective.

Not possible to identify separate effects of diet and/or exercise on prevention of weight gain.

Insufficient evidence to determine ideal “dose’ of exercise required to prevent weight gain.

Many of the trials are small(n), short term and describe weak experimental designs.
Is exercise an effective strategy for preventing weight gain in adults?

Questions:

1) Is it possible or important to identify the independent contributions of physical activity and diet for preventing weight gain?

2) What are the vital components of the ideal trial to determine the effects of lifestyle as a strategy for prevention of weight gain?
Acknowledgement

Research Funding

Canadian Institutes of Health Research (CIHR)

Thank You
Inter-individual variation in CRF response at 24 weeks to standardized exercise: effects of exercise amount and intensity

### LALI
- Change in absolute VO2 peak (L/min)
- Mean: 0.264 ± 0.249 L/min

### HALI
- Change in absolute VO2 peak (L/min)
- Mean: 0.406 ± 0.305 L/min

### HAHI
- Change in absolute VO2 peak (L/min)
- Mean: 0.627 ± 0.283 L/min

= technical error of measurement

= non-response within the technical error of measurement
Lifestyle and Cardiometabolic Research Unit

Staff....

Students....
Physical activity and nutrition programs for couples: A randomized controlled trial

- Participants: 137 couples
- Intervention: Three groups: low level intervention (modules mailed), high-level intervention (half of modules mailed, half delivered at interactive group sessions), control
  - Intervention materials focused on diet and physical activity
- Duration: 4-months with 1 year follow-up
Primary Findings

- Weight change: 0.78 kg between groups

- Secondary findings: Positive effects were seen mostly in mothers and daughters, less so with fathers and sons.
  - Steps per day increased across all intervention family members