Summer 8-11-2012

Resistance Exercise vs. Aerobic Exercise for Reduction of HbA1c in Type 2 Diabetics: A Systematic Review

Kelby Stout

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Resistance Exercise vs. Aerobic Exercise for Reduction of HbA1c in Type 2 Diabetics: A Systematic Review

Abstract

Background: Type 2 diabetes is the most common form of diabetes and can lead to many complications. Reduction of HgA1c is shown to decrease complications. Both aerobic exercise and resistance exercise have been shown to reduce HgA1c, but it is unclear if one method is better than the other at reducing HbA1c.

Method: Exhaustive search of available medical literature using Medline, CINAHL and EBMRM. Search terms included “Type 2 diabetes, resistance training and resistance exercise.”

Results: The search revealed 4 relevant articles. 2 of the articles showed no significant difference between the 2 types of exercise. The other 2 showed that resistance exercise was more effective than aerobic exercise at reducing HbA1c.

Conclusion: No distinction should be made on which type of exercise should be done by T2D to reduce HgA1c. For now, the best recommendation is to exercise more than 150 minutes a week, regardless of the type of exercise selected.

Degree Type
Capstone Project

Degree Name
Master of Science in Physician Assistant Studies

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Keywords
Type 2 diabetes, HbA1c, resistance exercise, aerobic exercise

Subject Categories
Medicine and Health Sciences

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Resistance Exercise vs. Aerobic Exercise for Reduction of HbA1c in Type 2 Diabetics: A Systematic Review

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A Clinical Graduate Project Submitted to the Faculty of the School of Physician Assistant Studies
Pacific University
Hillsboro, OR

For the Masters of Science Degree, August 2012

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Clinical Graduate Project Coordinator: Annjanette Sommers MS, PA-C, MS
Biography

Kelby Stout is from St. George Utah. He went to Dixie State College and Utah State receiving a Physical Education Degree. Before being accepted to Pacific University, he worked as a Physical Therapy Aide at Dixie Regional Medical Center. He is extremely grateful for the opportunity he has to be part of such a great profession and looks forward to the life of learning and growing in the medical field.
Abstract

**Background:** Type 2 diabetes is the most common form of diabetes and can lead to many complications. Reduction of HgA1c is shown to decrease complications. Both aerobic exercise and resistance exercise have been shown to reduce HgA1c, but it is unclear if one method is better than the other at reducing HbA1c.

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**Results:** The search revealed 4 relevant articles. 2 of the articles showed no significant difference between the 2 types of exercise. The other 2 showed that resistance exercise was more effective than aerobic exercise at reducing HbA1c.

**Conclusion:** No distinction should be made on which type of exercise should be done by T2D to reduce HgA1c. For now, the best recommendation is to exercise more than 150 minutes a week, regardless of the type of exercise selected.

**Keywords:** Type 2 diabetes, HbA1c, resistance exercise, aerobic exercise.
Acknowledgements

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List of Abbreviations

HbA1c……………………………………………………………………..Glycosolated Hemoglobin
BACKGROUND

The American Diabetes Association records that 25.8 million people in the United States, which amounts to 8.3% of the population, have diabetes. Another 79 million are estimated to be pre-diabetic. Type 2 diabetes is the most common form of diabetes and can lead to many serious complications including retinopathy, peripheral neuropathy, kidney disease and heart disease. In 2007, diabetes was listed as either the underlying cause, or as a contributing factor, in 231,404 deaths.

One target of therapy for type 2 diabetes has been a reduction of mean HbA1c to a level below 7%. Reduction of HbA1c by 1% has been shown by Stratton et al to drastically reduce the risk of micro-vascular endpoints, amputation and death from peripheral-vascular disease. This study also shows the same reduction in HbA1c can reduce the risk of stroke by 12%, heart attack by 14% and heart failure by 16%. Exercising at least 150 minutes a week has been recommended for those with impaired glucose tolerance and can result in a reduction in HbA1c. Umpierre et al notes that advice on physical activity, when combined with dietary counsel, can lead patients toward a decrease in HbA1c.

Aerobic exercise was believed to be the best way to reduce HbA1c. However, a systematic review done by Irvine and Taylor suggests that resistance training is also a reasonable option for reduction in HbA1c in type 2 diabetic patients. Studies have shown that a combination of aerobic and resistance training may be more beneficial than either alone. Bweir et al has suggested that resistance exercise is more beneficial than aerobic training for the reduction of HbA1c in Type 2 Diabetics. Ng et al suggests that
“there is a need to further study the relative benefits of aerobic exercise and progressive resistance exercise in patients with type 2 diabetes.”

It has been proven that both aerobic exercise and resistance exercise can be used to reduce HbA1c in type 2 diabetics, but is one type of exercise better than the other? The purpose of this review is to answer this question: Is resistance exercise better at reducing HbA1c than aerobic exercise in type 2 diabetic patients?

**METHODS**

Relevant articles were identified by performing a literature search on Medline (Ovid), CINAHL (Ebscohost) and EBMRM (Ovid). Search terms used were type 2 diabetes, resistance training and resistance exercise. The search only included articles that were written in English and were of human patients. Included were articles that compared resistance exercise with aerobic exercise. All articles included looked at type 2 diabetics with mean reduction of HbA1c as a primary or secondary outcome. Articles were not included if they had no between group comparisons of aerobic exercise and resistance exercise. Articles were also excluded if there was any resistance training in the aerobic exercise group or aerobic training in the resistance exercise group.

A search of the references from relevant articles was performed to evaluate if any other articles might meet the inclusion criteria. The GRADE scoring system was done for each article included. Articles were not excluded based on their GRADE score.

**RESULTS**

The search of Medline resulted in 118 articles, 118 articles were likewise found in CINAHL and 62 articles were found in EBMRM. Duplicate articles were discarded and a manual search of relevant articles from the reference list was performed. The search
yielded 4 relevant articles that were included in the review. Each article was reviewed using the GRADE criteria (see Table 1).

Ng et al

Ng et al\textsuperscript{8} conducted a randomized trial of type 2 diabetic patients that were recruited from the Diabetes Center of Singapore Hospital. Patients were randomized into an experimental group (resistance exercise) and a control group (aerobic exercise). Each group participated in an 8 week supervised exercise program. They were evaluated with a baseline measurement of HbA1c which was compared to the post therapy measurement to assess the mean reduction in HbA1c over the 8 week period. The study included participants who were 50 years or older, with a baseline HbA1c measurement of 8\% to 10\% and had previously been defined as sedentary. The study was done for only 8 weeks and no medication changes were allowed during the trial to eliminate the possibility of confounding factors.\textsuperscript{8}

The study included 60 participants total of whom 30 were randomized into each study group. Both groups completed 2-3 exercise sessions per week consisting of a 10 minute warm-up followed by approximately 50 minute workouts. Each group was scheduled to complete 18 sessions over the 8 week period. A total 82\% of the participants completed the trial (5 in the resistance group and 6 in the aerobic group did not). No information was given on the reason for their loss to follow up. The study did not include a non-exercise control group as the goal of the study was to compare resistance to aerobic exercise.\textsuperscript{8}

The resistance exercise group had a decrease in HbA1c of 0.4\% while the aerobic exercise group had a decrease of 0.3\%. The mean difference of the resistance group
compared to the aerobic group was not significant (see Table 2). The resistance exercise group had a greater reduction in waist circumference than the aerobic exercise group. However, the resistance exercise group had less of a reduction in systolic blood pressure and less of an increase in peak oxygen consumption than the resistance exercise group. No other significant between group differences were noted in this study.8

Sigal et al

Sigal et al5 conducted a randomized trial of previously inactive patients with type 2 diabetes. Patients were randomly assigned to 1 of 4 groups; resistance exercise, aerobic exercise, combined exercise and a control group with no change to pre-study activity. The study included patients that were 39-70 years old, had been diagnosed type 2 diabetics for at least 6 months and had baseline HbA1c levels between 6.6 % and 9.9 %. Exercise intervention took place in 8 facilities in the Ottawa-Gatineau, Canada region and was supervised by personal trainers.5

All participants completed a 4 week run-in phase to assess for adherence. In each session the participants performed both aerobic and resistance exercises at moderate intensity. Participants that did not show up for at least 10 of the 12 sessions in the run-in phase were excluded from the trial. Baseline measurements and randomization were done after this run-in phase. The resistance group performed 7 different weight lifting exercises per session. They progressed to where they would perform 2 to 3 sets of each exercise at the maximum weight they could lift 7-9 times. The aerobic exercise group started their program with 15-20 minutes of exercise at 60% of maximum heart rate and progressed to 45 minutes at 75% of maximum heart rate. The combined group performed
the full regimen aerobic and resistance exercise. All participants had the same dietary intervention. The trial intervention phase was 6 months. The resistance exercise group had a decrease in HbA1c of 0.3% while the aerobic group had a reduction in HbA1c of 0.43%. The mean difference of the resistance group compared to the aerobic group was 0.13%. Reid et al notes the 95% confidence interval from this trial as -0.24% to 0.5% (See Table 2). No significant between group comparisons were noted in this trial. The combined exercise group had a mean reduction in HbA1c of 0.9% which was significant when compared to either the aerobic exercise group or the resistance exercise group individually.

Cauza et al

Cauza et al conducted a randomized controlled trial of patients with type 2 diabetes. Participants included, ranged from 50 to 70 years old and had no other complications or co morbid conditions. All of the participants had fasting glucose levels of 126 mg/dl or greater and met the WHO criteria for Type 2 Diabetes. The participants were divided into one of two groups, a strength training group (resistance training) and endurance training group (aerobic training). The endurance training group acted as the control. The study included 21 participants in the endurance training group and 22 in the strength training group.

Participants in the strength training group performed 3 sets of 10 to 15 repetitions for each muscle group per week. Weight was increased when the participant successfully completed 15 repetitions in one set. The endurance training group exercised on a cycle ergometer on 3 nonconsecutive days each week. They started at 15 minutes per session and increased by 5 minutes per session every 4 weeks. Each group completed 4 months
of the training sessions and HbA1c was assessed both at baseline and after the training period.\textsuperscript{11}

The resistance training group had a decrease of 1.2% HbA1c while the aerobic training had a decrease of 0.3%. The mean difference of the resistance group compared to the aerobic group was -0.9%. No confidence interval was given but the p value was 0.04. Cauza et al\textsuperscript{11} notes that one limitation of the study was that the baseline fasting blood glucose levels of the strength training group was much greater than that of the endurance training group at randomization (204 to 160 mg/dl respectively) and can be reduced more easily because of the higher starting point. Cauza et al\textsuperscript{11} notes that there was a 30-50% increase in muscle strength with strength training and no increase in strength with endurance training. However, with strength training, there was less of an improvement in VO2 max.\textsuperscript{11}

Bweir et al

Bweir et al\textsuperscript{7} conducted a controlled trial of patients with type 2 diabetes. The study included participants from 45 to 65 years old with HbA1c levels of 7% to 10%. The participants were divided into a resistance training group and an aerobic training group. The study included 10 participants in each group.\textsuperscript{7}

The resistance training group performed 7 different exercises for 3 sets of 8-10 repetitions performed for each. Heart rate monitors were used to adjust the workload to reach 60% of their maximum heart rate at the beginning of the program and progressed to 75% of their maximum heart rate at the end. Participants in the aerobic training group progressed from 20 minutes per session at 60% of their maximum heart rate to 30 minutes per session at 75% of their maximum heart rate.\textsuperscript{7}
Bweir et al\textsuperscript{7} reports that resistance exercise results in a greater reduction of HbA1c than aerobic exercise. No mean reduction value was given in the study but the p value reported was p < 0.01. They also note that 40\% of the participants in the resistance group reached the target value of 7\% while none of the participants in the aerobic group reached below 7\%.\textsuperscript{7}

**DISCUSSION**

**Resistance training vs. Aerobic training**

Cauza et al\textsuperscript{11} and Bweir et al\textsuperscript{7} were the studies that showed a difference in HbA1c reduction when comparing the resistance training group to the aerobic training group. This difference was statistically significant even with the low numbers in the trials. However, the confounding factor of the higher fasting blood glucose levels and higher baseline HbA1c makes it easy to dismiss the results from Cauza et al.\textsuperscript{11} Also, the endurance training group started with just 15 minutes of endurance training and increased every 4 weeks while the strength training group increased their intensity on an ongoing basis. This means that the strength training group might have had more intensity to their workouts than the endurance training group. Another reason for the difference could be the strength training group possible having longer workouts than the endurance training group, especially during the first few months. Bweir et al\textsuperscript{7} had an even lower number of participants and did not appear to be randomized.

Sigal et al\textsuperscript{5} and Ng et al\textsuperscript{8} did not show any significant difference between the 2 groups. These studies had better between group comparisons without the confounding factors from Cauza et al.\textsuperscript{11} These studies also made more efforts to control for intensity
differences between groups. The study by Sigal et al\textsuperscript{5} also had a greater sample size between groups leading to more precise outcomes.

The claims made by Bweir et al,\textsuperscript{7} that resistance exercise is better than aerobic exercise for reducing HbA\textsubscript{1c}, are unfounded as was demonstrated by these other studies\textsuperscript{5,9} conducted on the same topic. Other benefits of resistance exercise might make it a better option for some patients on a case by case basis. Ng et al\textsuperscript{8} showed a greater reduction in waist circumference. Cauza et al\textsuperscript{11} showed the strength gains that come from strength training compared to endurance training. However, Ng et al\textsuperscript{8} showed a greater reduction in blood pressure from endurance training. Each patient with type 2 diabetes might have different goals and needs that could make one type of training a better option for them than the other. As far as reduction in HbA\textsubscript{1c} goes, however, they appear to be equal.

\textbf{Combined Exercise}

While this area was not a subject of this review, there is some suggestion that a combination of resistance and aerobic training exercise appears to be a better option than either alone. Sigal et al,\textsuperscript{5} for example, showed this to be the case. Church et al\textsuperscript{6} performed a study comparing combined exercise with aerobic exercise alone with similar results.

Too few studies have been done with a combined exercise group that controlled for time and intensity to know the exact role each plays. Boulè et al\textsuperscript{12} claims that a more intense exercise regimen can lead to a greater reduction in HbA\textsubscript{1c}. Umpierre et al\textsuperscript{4} shows that exercise programs that exceed than 150 minutes further reduce HbA\textsubscript{1c}. Any differences found between resistance exercise and aerobic exercise might have been due to the differences in time or intensity during those exercise programs. Efforts need to be
made to control these possible confounding factors to determine if all exercise is equal, or if a combined program with aerobic exercise and resistance exercise can have a synergistic effect on HbA1c reduction.

**Limitations of Study**

Each study was assessed using the GRADE criteria (see table 1). Sigal et al\(^5\) and Ng et al\(^8\) both received a moderate grade while Cauza et al\(^11\) and Bweir et al\(^7\) both received a very low grade. All of the studies were deducted for indirectness as HbA1c is a surrogate outcome and patient important outcomes were not used. Cauza et al\(^11\) made no mention of randomization while Bweir et al\(^7\) appeared to not have been randomized at all and were deducted accordingly. Cauza et al\(^11\) had a significant difference in baseline HbA1c between the resistance group and aerobic group and was deducted for inconsistency. Cauza et al\(^11\) and Bweir et al\(^7\) both had smaller study groups and were deducted for inconsistency.

An important distinction to make between the participants in these studies and most patients is that they were all on a prescribed exercise program. When counsel is given to patients to exercise, compliance becomes a large issue. Many patients may not know where to start or may lack the motivation to exercise on their own. Umpierre et al\(^4\) showed that a structured exercise program, regardless of the training type, had greater effects on reduction of HbA1c than physical activity advice alone. Is it enough to just ask patients to exercise, or does a specific training program need to prescribe?

The longest study in this review was for approximately 5 months. None of the studies looked at any long term outcomes or had any follow up after the completion of the training period. While exercise might help reduce HbA1c, it may continue to
decrease, maintain at that level or return to baseline. Other outcomes would be more important for the patients as well. These patient important outcomes include peripheral vascular disease, heart attack, retinopathy, amputations and death from diabetes. While the HbA1c might be reduced, it might not lead to decreased rates of these outcomes. HbA1c also might not be enough to motivate patients. These patient important outcomes need to be studied to better understand the role of exercise in patients with type 2 diabetes.

The short term and long term implications of a prescribed exercise program also need to be better understood. A two month exercise program with a personal trainer may better for the patient long term than instruction alone. Follow up on further studies should be at least 5 years and look at outcomes such as the reduction or increased need for medication and assessment of diabetes related complications like retinopathies, kidney disease and amputations.

CONCLUSION

No distinction need be made on which type of exercise should be done by type 2 diabetics to reduce HbA1c. Combined exercise might be a better option than either alone. More studies need to be done on exercise intensity to determine if there is a link between intensity and reduction of HbA1c. Studies also should be done to determine if exercise programs should be prescribed instead of merely recommended exercise. For now the recommendation should remain to exercise at least 150 minutes a week regardless of the type of exercise.
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<table>
<thead>
<tr>
<th>Study</th>
<th>Illustrative comparative risks*</th>
<th>Relative effect (95% CI)</th>
<th>No of Participants</th>
<th>Quality of the evidence (GRADE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ng et al</td>
<td>The mean change HbA1c in the control group was -0.3 % difference in HgA1c</td>
<td>(-0.5 to 0.3)</td>
<td>60</td>
<td>⊗⊗⊗⊗ moderateA</td>
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<tr>
<td>Sigal et al</td>
<td>The mean change HbA1c in the control group was -0.43 % difference in HgA1c</td>
<td>(-0.24 to 0.5)</td>
<td>124</td>
<td>⊗⊗⊗ moderateA</td>
</tr>
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<td>Cauza et al</td>
<td>The mean change HbA1c in the control group was -0.3 % difference in HgA1c</td>
<td>(no confidence interval given)</td>
<td>29</td>
<td>⊗⊗⊗⊗ very lowA,B,C,D</td>
</tr>
<tr>
<td>Bweir et al</td>
<td>The mean change HbA1c in the control group was not given</td>
<td>(no confidence interval given)</td>
<td>20</td>
<td>⊗⊗⊗⊗ very lowA,B,C</td>
</tr>
</tbody>
</table>

* The basis for the assumed risk (e.g. the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CI: Confidence interval;
### GRADE Working Group grades of evidence

**High quality**: Further research is very unlikely to change our confidence in the estimate of effect.

**Moderate quality**: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

**Low quality**: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

**Very low quality**: We are very uncertain about the estimate.

---

\(^a\) Surrogate outcomes were used and no treatment effect can be determined with the measured outcomes.

\(^b\) No mention of confidence interval was made.

\(^c\) No mention of blinding or concealment was made in the study.

\(^d\) The two study groups did not start from the same baseline. The resistance training group had higher HgA1c levels and higher blood glucose levels to begin with and had much more to lose.