Disrupting Sedentary Time in Adults with DMT2 Can Result in Decreased BMI and Increased Weight Loss

Megan Margeson

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Disrupting Sedentary Time in Adults with DMT2 Can Result in Decreased BMI and Increased Weight Loss

Abstract

Background: Diabetes mellitus type 2 affects millions of people across the world. The problem is only increasing. In addition to medications, most interventions have focused on diet and exercise, and these regimens prove difficult to many patients. Recent data has shown that sedentary behavior can have negative effects on overall health in healthy and diabetic patients alike. This systematic review focuses on the benefit to waist circumference (WC) and body mass index (BMI) by breaking up long bouts of sedentary time.

Methods: An exhaustive medical literature search was conducted using MEDLINE-Ovid, CINAHL, and Web of Science using the keywords: diabetes mellitus type 2, sedentary lifestyle, and motor activity.

Results: The two studies that met inclusion criteria show that prolonged sedentary behaviors in adults with DMT2 had significant associations with increased WC and BMI. Both studies used isometrial substitution analysis to correlate a decrease in BMI and WC when prolonged sitting time was replaced with shorter bouts of sitting time.

Conclusion: While moderate to vigorous activity remains one of the best interventions for adults with DMT2 in controlling WC and BMI, this patient population can benefit with a simple intervention of reducing prolonged sedentary activity to no more than 30 minutes at a time.

Keywords: Diabetes mellitus type 2, physical activity, and sedentary lifestyle.

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Degree Name
Master of Science in Physician Assistant Studies

Keywords
Diabetes, BMI, Weight loss, sedentary time, waist circumference

Subject Categories
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Megan Margeson
Biography

[redacted for privacy]
Abstract

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Acknowledgements

To my family: Thank you for always believing in me.
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List of Abbreviations

DMT2 Diabetes Mellitus Type 2
WC Waist Circumference
BMI Body Mass Index
LPA Light Physical Activity
MVPA Moderate to Vigorous Physical Activity

Disrupting Sedentary Time in Adults with DMT2 Can Result in Decreased BMI and Increased Weight Loss
BACKGROUND

“Sitting is the new smoking.” This is a topic that has been covered by TED Talks, Huffington Post, Forbes, MayoClinic, and has even been referenced by mainstream movies like “The Intern.” Recent studies\(^1\) have shown that sitting for long periods of time increases waist circumference, BMI, risk of metabolic syndrome, and risk for cardiovascular disease, stroke and diabetes. This is especially surprising as the amount of exercise one does is not protective; in other words, if you sit for 8 hours per day and exercise for 1 hour you are at the same risk as those who do not exercise at all.\(^2\)\(^-\)\(^5\)

Diabetes mellitus type 2 (DMT2) is a disease that is currently affecting over 29 million people or 9.3\% of the Unites States population. It is the sixth leading cause of death in the US. Diabetes can cause a myriad of complications including hypertension, myocardial infarction, stroke, kidney disease, skin ulcers, neuropathies, amputations, and early death.\(^6\) Currently, management of DMT2 ranges from daily medication, to changes in diet, to increases in activity and exercise;\(^7\) however, the problem persists and continues to deteriorate. While increasing exercise has proven effective for glycemic control,\(^8\) moderate to vigorous physical activity remains a difficult challenge for most patients. Recent studies\(^1\)\(^-\)\(^3\) have focused on the negative impacts of prolonged sedentary time in adults, regardless of physical activity. Results of a meta-analysis\(^1\) noted that all-cause mortality, cardiovascular disease, cancer incidence and mortality, and DMT2 were increased when related to prolonged sedentary time, even when adjusted for physical activity.
Previous studies\textsuperscript{9-11} have also highlighted the increased incidence of sedentary time in the majority of patients with DMT2. When adults with DMT2 have higher sedentary time they also have a poor metabolic profile.\textsuperscript{2-4} A possible intervention to this problem is to break up prolonged sedentary time with short breaks. This systematic review asks: Can disrupting sedentary time in adults with DMT2 result in decreased BMI and increased weight loss?

**METHODS**

An exhaustive medical literature search was conducted using MEDLINE-Ovid, CINAHL, and Web of Science using the keywords: diabetes mellitus type 2, sedentary lifestyle, and motor activity. The search was narrowed by including only English language articles, studies performed on humans, and publication dates within the last 5 years. The bibliographies of the articles were also searched for relevant sources. Articles that focused on shorter bouts of sitting and an outcome of improved BMI and weight loss were included. Relevant articles were assessed for quality using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE).\textsuperscript{12}

**RESULTS**

The initial search of the above mentioned databases yielded 122 articles for review. After applying the eligibility criteria, removing duplicates, and scanning abstracts for eligibility, 7 articles were read in their entirety. Two were considered eligible for this
systematic review and are reviewed below.\textsuperscript{13,14} Table 1 shows a quality assessment of the articles chosen.

\textbf{Study 1: Accelerometer derived sedentary and physical activity time (LWWD)}

Socio-demographic and cardio-metabolic characteristics of the participants can be found in the article\textsuperscript{13} or from the Living Well With Diabetes (LWWD) sample, which have been reported previously. The 285 participants were Australian born with DMT2, aged 25-70 and with a BMI over 25kg/m2. The median HbA1c was 7.1%; most used traditional oral medication (77\%) and 14\% used insulin. Seventy-one percent of the participant’s BMI fell into the obese category (BMI > 30kg/m2) and 32 participants (11.5\%) had a BMI greater than 40. Sedentary waking hours was 62.7\% (SD 10.8). The remaining waking hours were spent with 35\% (SD 10.0) in light-intensity activity (LPA), and 2.2\%(SD 2.1) in moderate-to-vigorous physical activity (MVPA). Over 25\% of sedentary time was accumulated in bouts of greater than 30 minutes.\textsuperscript{13}

Prolonged sedentary behavior had significant associations with higher waist circumference (+0.67 cm) and BMI (+0.33 kg/m2) per 30min/day. Light-intensity activity showed statistically significant associations with lower WC, BMI, and fasting plasma glucose (-0.61 cm, -0.29 kg.m2 and -2\% lower per 30min/day, respectively). This data is presented in Table 2. No associations were found between non-prolonged sedentary time and MVPA. None of these associations remained statistically significant when adjusted for other activities.\textsuperscript{13}
The next association looked at was isotemporal substitution. When looked at cross-sectionally, decreasing prolonged sedentary time and replacing it with light-intensity activity time (+30min/day) was associated with significantly lower WC (-0.77cm).13

Study 2: The potential impact of displacing sedentary time. (Early ACTID)

The Early ACTID study14 was comprised of 593 participants, 519 of these fulfilled criteria to be included in this accelerometer study. Demographics can be found in the article. Sedentary time for these participants was 65% of the day and 46 % of this was in bouts longer than 30 minutes. Participants spent an average of 25.4 +/- 18.9 min of the day in MVPA and 272.5 +/- 75.4 in LPA.14

Regression analysis results for long-bout sedentary time, short-bout sedentary time, LPA, and MVPA are shown in Table 2. Higher BMI (adjusted beta, 0.41; 95% CI 0.26,0.56) and larger WC (adjusted beta 1.03; 95%CI 0.69, 1.37) and also a lower HDL-cholesterol (adjusted beta, -0.02, CI -0.03, -0.01). There were no other biomarker associations found in this study. A decrease in BMI was shown for short-bout sedentary time (-0.71 [-1.11,-0.33]), LPA (-0.41 CI [-0.61, -0.22]), and MVPA (-2.15 CI [-2.87, -1.44]). Associations were also seen for a decrease in waist circumference for short-bout sedentary time (-1.63 CI[-2.51, -0.76]), LPA (-1.15 CI [-1.60, -0.70]), and MVPA (-4.49 CI [-6.16, -2.82]). All data listed had a statistical significance of P<0.05 level.14

An isotemporal substitution analysis was performed and results are shown in Table 3. Using cross-sectional analysis, reallocating 30 minutes per day in long bouts of sedentary time with 30 minutes of short-bout sedentary time, LPA, or MVPA was associated with a lower BMI and WC. These associations were stronger than the single-activity
models. Replacing 30 minutes of long-bout sedentary time with 30 minutes of short-bout sedentary time was associated with both a decrease in BMI (adjusted beta, -0.60; 95% CI -1.00, -0.21) and decreased WC (adjusted beta, -1.16; 95% CI -2.08, -0.25). Reallocation 30 minutes of short-bout sedentary time and LPA with 30 minutes of MVPA has an even stronger association with reduced BMI (-1.87 CI[-2.59, -1.14]; -2.00 CI [-2.74, -1.26] respectively), and waist circumference (-3.97, CI [-5.65, -2.28]; -3.93, CI [-5.65, -2.21] respectively).

**DISCUSSION**

The studies\textsuperscript{13,14} showed similar strengths and limitations. Both were able to objectively measure activity over multiple intensities with the use of accelerometers. Both measured a clinically important population. Study 1 and 2 had a large population size that proved to have statistically significant outcomes with Study 2 having the best number at 519. Both studies\textsuperscript{13,14} showed that overweight and obese adults with DMT2 spend a large amount of time sedentary. When compared to healthy adults, more time is spent sedentary even when the time spent in MVPA is equal.\textsuperscript{15} It is common that this sedentary time is spent in prolonged bouts.\textsuperscript{13,14} While moderate to vigorous physical activity remains one of the best interventions for weight loss in a diabetic patient,\textsuperscript{16} reducing sedentary time may be a useful intervention in patient populations that are noncompliant or unable to perform more vigorous activity. This could also be a useful intervention for pre-diabetic patients. Patients could be educated to stretch or walk in place for 1-2 minutes every
30 minutes. For example, walk in place during commercial breaks when watching TV. These studies\textsuperscript{13,14} support such advice.

Weaknesses between both studies\textsuperscript{13,14} were also similar. Accelerometers, can be prone to error. They cannot measure changes in posture, for example, moving from sitting to prolonged standing. Accelerometers cannot be worn in water so activity during showering or swimming cannot be measured. In addition, many participants did not wear the device for all 7 days; however, they were worn for the required 4 day minimum to be included in the study. Lastly, the studies\textsuperscript{13,14} didn’t fully address the length of time for LPA or MVPA, but did imply the need to move around every 30 minutes.

CONCLUSION

A comparison of the results of two studies found that both WC and BMI can be improved by replacing long bouts of sedentary time with light physical activity. Simple LPA and breaking up prolonged sedentary time with short breaks shows improvements in overweight adults with DMT2. Future studies that could measure the difference between sitting vs standing and measure data a priori over a longer period of time might be beneficial in directing treatment for overweight patients with DMT2. In the meantime, advising
adult patients with DMT2 to break up their sedentary bouts in segments of less than 30 minutes could be a beneficial addition to management.
Table 1: Quality Assessment of Reviewed Articles

<table>
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<th>Outcome</th>
<th>Number of studies</th>
<th>Study Designs</th>
<th>Downgrade Criteria</th>
<th>Upgrade Criteria</th>
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<td>Limitations</td>
<td>Indirectness</td>
<td>Inconsistency</td>
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<td>Cohort</td>
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<td>Not Serious</td>
<td>Not Serious</td>
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<tr>
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<td>2</td>
<td>Cohort</td>
<td>Not Serious</td>
<td>Not Serious</td>
<td>Not Serious</td>
</tr>
</tbody>
</table>

*Travel expenses were covered by OERC and Ergotron when GNH (author) presented this study.

TABLES

References


TABLE 2. Time Spent in Activity with Outcome

<table>
<thead>
<tr>
<th>BMI</th>
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<th>Replacing Short bout sed with:</th>
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<td>LPA</td>
<td>MVPA</td>
<td>LPA</td>
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<tr>
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<td>-0.69 (-1.46, 0.08)</td>
<td>-0.77 (-1.33, 0.22)</td>
<td>0.64 (1.96, 3.24)</td>
</tr>
<tr>
<td>Study 2. CL. Falconer: The Potential Impact...</td>
<td>-0.60 (-1.00, -0.21)</td>
<td>-0.26 (-0.47, -0.05)</td>
<td>2.19 (-2.89, -1.49)</td>
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</table>

<table>
<thead>
<tr>
<th>WC</th>
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<th>Replacing Short bout sed with:</th>
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<td>LPA</td>
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<td>Study 1. GN Healy: Acclerometer-derived sedentary...</td>
<td>-0.35 (-0.70, -0.01)</td>
<td>-0.36 (-0.61, -0.11)**</td>
<td>0.20 (-0.93, -0.11)**</td>
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<td>Study 2. CL. Falconer: The Potential Impact...</td>
<td>-1.16 (-2.08, -0.25)</td>
<td>-0.87 (-1.35, -0.39)</td>
<td>-4.56 (-6.19, -2.93)</td>
</tr>
</tbody>
</table>

Bold indicates statistical significance at the P< 0.05 level; **P< 0.01

- 14 -


5. Stamatakis E, Davis M, Stathi A, Hamer M. Associations between multiple indicators of objectively measured and self-reported sedentary behavior and cardiometabolic risk in older adults. Pre Med. 2012; 54; 82-87


