

Summer 8-9-2014

The Effects of Postprandial Walking on Glycemic Control in Adults at Risk for Impaired Glucose Tolerance and Type 2 Diabetes

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Abstract

Background: Studies have shown that postprandial hyperglycemia is a risk factor for developing diabetes type 2 and cardiovascular disease. Herein is the systematic evaluation of whether postprandial light walking will reduce and delay the increase in postprandial plasma glucose level.

Methods: An exhaustive electronic search of Medline-OVID, CINAHL, and EBMR Multifile was conducted using the following keywords: postprandial period, postmeal, blood glucose, walking, and motor activity. Inclusion criteria included all study designs. The search was narrowed down to the English language and studies on humans. Studies were eligible if they included human adults, had clearly defined controls, had prognostically balanced intervention and control groups, evaluated postprandial walking, and measured blood glucose levels. Relevant articles were assessed for quality using the Grading for Recommendations, Assessment, Development and Evaluation (GRADE).

Results: Two studies were included in this review. Both studies were crossover study trials that examined the effects of postprandial walking on post meal plasma glucose levels. Overall, the trials included impaired glucose tolerant elderly men and women and middle-age diabetic-prone Pakistani women immigrants. The physical activities performed post meal included 20 and 40 minutes of light walking, 45 minutes sustained treadmill walking, and 15 minutes of treadmill walking after each meal. All the crossover trials demonstrated that walking post meal reduced the rise in postprandial blood glucose.

Conclusion: These results suggest that even low intensity physical activity such as walking can be beneficial in blunting and delaying the rise in postprandial plasma glucose. Moreover, 15 minutes of walking performed after each meal has the same effect as 45 minutes of sustained walking performed once a day. The studies in this review, however, are crossover studies with small sample sizes and are considered as very low quality on the GRADE scale. More evidence from a larger, well-designed randomized control trial is needed in order to validate this recommendation to the general population.

Keywords: Postprandial, post meal, blood glucose, walking, human

Degree Type

Capstone Project

Degree Name

Master of Science in Physician Assistant Studies

Keywords

Postprandial, post meal, blood glucose, walking, human

Subject Categories

Medicine and Health Sciences

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**The Effects of Postprandial Walking on Glycemic Control in Adults at
Risk for Impaired Glucose Tolerance and Type 2 Diabetes**

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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 9, 2014

Faculty Advisor: Mark Pedemonte, MD

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

Biography

[Redacted for privacy]

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Methods: An exhaustive electronic search of Medline-OVID, CINAHL, and EBMR Multifile was conducted using the following keywords: postprandial period, postmeal, blood glucose, walking, and motor activity. Inclusion criteria included all study designs. The search was narrowed down to the English language and studies on humans. Studies were eligible if they included human adults, had clearly defined controls, had prognostically balanced intervention and control groups, evaluated postprandial walking, and measured blood glucose levels. Relevant articles were assessed for quality using the Grading for Recommendations, Assessment, Development and Evaluation (GRADE).

Results: Two studies were included in this review. Both studies were crossover study trials that examined the effects of postprandial walking on post meal plasma glucose levels. Overall, the trials included impaired glucose tolerant elderly men and women and middle-age diabetic-prone Pakistani women immigrants. The physical activities performed post meal included 20 and 40 minutes of light walking, 45 minutes sustained treadmill walking, and 15 minutes of treadmill walking after each meal. All the crossover trials demonstrated that walking post meal reduced the rise in postprandial blood glucose.

Conclusion: These results suggest that even low intensity physical activity such as walking can be beneficial in blunting and delaying the rise in postprandial plasma glucose. Moreover, 15 minutes of walking performed after each meal has the same effect as 45 minutes of sustained walking performed once a day. The studies in this review, however, are crossover studies with small sample sizes and are considered as very low quality on the GRADE scale. More evidence from a larger, well-designed randomized control trial is needed in order to validate this recommendation to the general population.

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Acknowledgements

[Redacted for privacy]

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Table 1: GRADE Quality of Evidence

List of Abbreviations

GRADE Evaluation	Grading for Recommendations, Assessment, Development and
W20	Walking 20 minutes
W40	Walking 40 minutes
BMI	Body Mass Index
PV	Peak value
TTP	Time to peak

The Effects of Postprandial Walking on Glycemic Control in Adults at Risk for Impaired Glucose Tolerance and Type 2 Diabetes

BACKGROUND

It has been well established that high plasma glucose levels are associated with diabetes and coronary heart disease.^{1,2} Furthermore, postprandial hyperglycemia is an independent and important risk factor for impaired glucose tolerance, diabetes type 2, and cardiovascular disease.² In addition some observers concluded that postprandial hyperglycemia and postprandial glycaemic spikes are more strongly associated with atherosclerosis than fasting glucose or the HbA1c level.³ Patients with hyperglycemia take medications or insulin injections to lower their postprandial plasma glucose levels. Also, it is a common recommendation that physical activity reduces blood glycaemic levels. Past studies have suggested that even light physical activity, such as stationary light bicycling, can appreciably lower postprandial glycaemic levels.⁴⁻⁶ Since physical activity is an effective measure for glycaemic control, it is reasonable to suggest that walking after meals can also be effective in controlling postprandial blood glucose. Thus, the aim of this systematic review is to assess the effects of postprandial walking on glycaemic control in adults at risk for impaired glucose tolerance and diabetes type 2.

METHODS

This systematic review was conducted with a specified search strategy and eligibility criteria. An exhaustive electronic search of Medline-OVID, CINAHL, and EBMR Multifile was conducted using the following keywords: postprandial period, postmeal, blood glucose, walking, and motor activity. Inclusion criteria included all

study designs. The search was narrowed down to the English language and studies on humans. Studies were eligible if they included human adults, had clearly defined controls, had prognostically balanced intervention and control groups, evaluated postprandial walking, and measured blood glucose levels. Relevant articles were assessed for quality using the Grading for Recommendations, Assessment, Development and Evaluation (GRADE).⁷ Details of each trial including intervention, duration, participants, quality, and outcome were examined.

RESULTS

From the initial database searches, 150 articles were identified. After screening the abstracts, 143 articles were rejected because they did not meet the eligibility criteria, and seven potentially relevant articles remained. After full text review of the remaining seven articles, five articles were eliminated. One article⁸ was rejected because the study was comparing two prognostically different groups. Three articles^{4, 5, 9} were rejected because the interventions were bicycling and stair climbing instead of walking. One article⁶ was rejected because the study was performed only on all healthy subjects instead of those with impaired glucose tolerance or who are at risk of diabetes type 2. The remaining two articles^{10, 13} met the inclusion criteria and were reviewed in full detail.

Lunde et al crossover study

This crossover study¹⁰ was designed to include participants consisting of Pakistani women immigrants living in Norway. In this study, 11 diabetic-prone Pakistani women age 36-50 years, with a mean age of 44 years participated. These women were participating in another study conducted on immigrant groups, and discovered they were diabetic-prone based on their BMI and waist hip ratio as compared to other immigrant

groups¹¹ living in Oslo, Norway. Pakistani women living in Norway do not participate much in vigorous physical activity. They do, however, practice low intensity walking on a regular basis. During the screening, five of the participants were found to have impaired glucose tolerance. The objective of the study was to see what effect slow post meal walking immediately performed after ingestion of a meal has on diabetic-prone subjects' postprandial blood glucose. Subjects on glucose lowering agents were excluded from the study.¹⁰

In this crossover design trial, three phases were conducted, each separated by 1 week. Day 1, the first phase, served as the control in which participants were resting after ingestion of a prescribed meal. During the second phase, participants were instructed to walk in their usual, slow, and comfortable pace for 20 minutes, and the final phase was similar except participants walked for 40 minutes. After walking, participants rested with no physical activity throughout the postprandial period. Participants fasted for 12 hours, overnight, prior to each phase, and a pre-meal fasting blood glucose level was measured. Then participants ate the prescribed meal which consisted of milk and cornflakes and were required to consume the 50g of carbohydrates within 15 minutes. Each subject's blood glucose level was measured every 15 minutes for 120 minutes postprandially. Between phases, participants were asked to conduct activities of daily living as similarly as possible as the day before each phase. Each participant's perceived physical exertional level was described in the Borg's Scale of Perceived Exertion.¹² One subject did not participate in the 40 minute walk, thus only 10 subjects were included in the analysis of this part of the intervention.¹⁰

The authors used SPSS for Windows, version 15.0 to test data for normality and analysis. To determine the effects of time and type of intervention, the authors used a one way repeated measure ANOVA. To test differences between corresponding values of peak value (PV), time to peak (TTP), and incremental area under the curve (IAUC), the authors used students *t* test, paired samples. For statistical significance, $p < 0.05$ was used. Data were presented as \pm SEM or SD. In addition, the authors also used the non-parametric Wilcoxon Signed Rank Test to evaluate their results.¹⁰

The primary outcome of the study was the overall postprandial glycemia. After completion of the meal and at rest, blood glucose increased in the first 30-45 minutes after ingestion of a 50 g carbohydrate meal. After the glyceemic level has reached its peak, it began to decrease, but was found to be higher than at baseline at the end of the 120 minute control experiment. On Intervention Day 1, very slow post meal walking for 20 minutes immediately following ingestion of the same meal showed a peak glucose value of 8.2% lower when compared to control, but this was not significantly different. However, the time to reach peak value was significant and was delayed by an average of 19 minutes compared to control ($p=0.002$; paired *t* test). In confirmation, using the non-parametric Wilcoxon Signed Rank Test, it was found that 20 minutes of post meal walking has no significance on PV, but there was significant delay in TTP ($p=0.010$). Lastly, for the 20 minutes post meal slow walk, the 2-hour incremental area under the glucose curve was reduced by 30.6% ($p=0.025$) as compared to control. For the 40 minute slow walking experiment, glucose peak value was decreased by 16.3% ($p=0.001$; paired *t* test), and the time to peak was delayed by 25 minutes ($p=0.001$; paired *t* test). Similarly, the Wilcoxon Signed Rank Test showed significant effects in decreasing PV

($p=0.005$) and delaying TTP ($p=0.011$) when compared to control. The 2-hour incremental area under the glucose curve for the 40 minute post meal walk was reduced by 39% ($p=0.006$).¹⁰

It is the authors' conclusion that slow post meal walking can blunt the rise in postprandial blood glucose in diabetic-prone subjects when performed immediately after a meal. The authors also discussed any carryover effect is unlikely as each phase was conducted 1 week apart. In addition, they also acknowledged their small sample size makes the results and conclusion appear exploratory, and this limits their validation and recommendation to the general population. Although, they acknowledged their limitations, the authors suggested their findings provided a basis for a practical lifestyle advice in the prevention of type 2 diabetes.¹⁰

DiPietro et al crossover study

In this study,¹³ the authors compared the effectiveness of 15 minutes of walking after every meal to one bout of sustained walking for 45 minutes.¹³ Ten subjects at risk for impaired glucose tolerance participated. The participants were elderly men and women with an average age 69 ± 6 years. Participants were recruited from senior centers and senior residential communities within the Washington, D.C. metropolitan area. Subjects were screened for eligibility for the study. Eligibility criteria include participants who were nonsmokers, were non-diabetic, had no cardiovascular disease, were not hypertensive, were not on any glucose lowering agents, had a BMI 30 ± 5 , and had less than 20 minutes of physical activity per week in the last 6 months. Fasting blood glucose was obtained to identify subjects at risk for impaired glucose tolerance and to filter out potential subjects who have undiagnosed diabetes. Participants with screening

fasting glucose between 105 and 125 mg/dL were identified as impaired glucose tolerance. The participants performed three random treadmill walking exercises, each separated by 4 weeks of washout period. Each experiment requires participants to stay in a whole room calorimeter for 48 hours with the first day serving as the control day. Each participant begins the control day and intervention day after fasting overnight in order to measure a baseline fasting blood glucose level. Glucose was monitored with a continuous glucose monitoring device placed subcutaneously at the umbilicus level. Each participant was served a standardized meal of ~32 kcal per kilogram per day of body weight before each experiment. On intervention days, participants perform 1 of 3 treadmill post meal walking exercises under supervision at the absolute intensity of 3.0 mets (treadmill speed 2.1 to 3.5 mph). One walking exercise consisted of 15 minutes of treadmill walking performed 30 minutes after every meal. The other two interventions involved sustained treadmill walking for 45 minutes: one performed 2 hours after breakfast and one performed in the afternoon before dinner. After each intervention, participants rested and stayed in the calorimeter without physical activity.¹³

Data for the *3-hour post lunch*, *3-hour post dinner*, and the *averaged 24-hour* glucose concentrations were compared. The results showed three bouts of 15 minutes of post meal walking and 45 minutes of sustained morning walking did not have significant impact on the *3-hour post lunch* glycemic level. However, three bouts of 15 minutes of postmeal walking did significantly reduced the *3-hour post dinner* glycemic level compared to control ($p < 0.01$). The 15-minute post meal walking also had significant impact on the 3-hour AUC post dinner glucose level compared to control ($p < 0.03$). It was not possible to measure the effects of the 45 minutes of afternoon walking on the 3-

hour post lunch glycemic level because this part of the exercise took place past the 3-hour post lunch period. Sustained 45 minutes of morning walk did not have significant effect on the *3-hour post dinner* blood glucose level. Sustained 45 minutes of afternoon walk appeared to increase the *3-hour post dinner* blood glucose level. For the *averaged 24-hour* blood glucose concentration, results showed three bouts of 15 minutes of post meal walking ($p < 0.03$) and one bout of 45 minutes of continuous morning walking ($p < 0.05$) were both equally effective when compared to control. However, one bout of 45 minutes of continuous afternoon walking had no significant impact on the *averaged 24-hour* glucose level.¹³

Three bouts of 15 minutes of postmeal walking appeared to be the only regimen that reduced the *3-hour post dinner* and the *averaged 24-hour* glucose concentration. The authors concluded that 15 minutes of walking after every meal was as effective as 45 minutes of sustained morning walking in controlling the 24-hour blood glucose level in elderly adults at risk for impaired glucose tolerance. They also concluded that 15 minutes of postmeal walking was effective in decreasing the *3-hour post dinner* blood glucose level while the morning part or the afternoon part of 45 minutes of sustained walking did not. Although the maximum exertional level performed in this study was only 3.0 mets, barely a moderate level, the authors suggested the timing of the exercise, rather than intensity, should be important considerations. They speculated that smaller bouts of intermittent exercises repeated several times per day, much like pharmaceutical drug doses, may provide greater benefits than a single large dose administered once per day.¹³

DISCUSSION

Overall, the results of the two studies^{10, 13} included in this review demonstrated that postprandial walking can reduce and delay the rise in postprandial blood glucose in impaired glucose tolerance and at risk adults. Similar studies by Høstmark et al⁴ conducted on sedentary and trained middle-aged women showed that regardless of age or training condition, light bicycling exercise after ingestion of a high glycemic meal was effective in blunting the increase in postprandial glycemia.⁴ In light of this, what is the lowest physical intensity that can be performed to have a glycemic lowering effect? A crossover study by Aadland et al⁵ attempted to answer this question with a study conducted on six healthy men and three healthy women in Norway. Their results showed that even very light exercise performed immediately after a meal can have a glucose lowering effect.⁵ However, their study involved light stationary bicycling for 30 minutes performed after eating which may be impractical, and the authors did not think most people will be willing to spend 30 minutes of physical activity after a meal.⁵ Nygaard et al⁶ showed similar results in a postprandial slow walking study conducted on healthy Caucasian females in Norway.⁶

While each of the two studies^{10, 13} in this review demonstrated the effectiveness of postprandial walking in controlling postprandial glycemia, these studies have serious limitations. They were not randomized, and there was no mention of blinding of any extent in the studies. In addition, they did not include participants of all ethnicities representative of the general population. The authors of each of the studies in this review acknowledged their limitations of small sample size. Nevertheless, both of the studies combined included one ethnic group of middle-aged women and one at risk group of

elderly participants. In both of the studies, all the participants started out prognostically balanced, and because they were crossover trials, each subject served as their own control. In spite of the studies being all crossover trials with small sample size; both of the studies showed the effectiveness of postprandial walking in lowering and delaying postprandial glycemic level.^{10, 13} Furthermore, the study by DiPietro et al¹³ demonstrated that 15 minutes of walking after each meal has the same effectiveness in 24-hour glycemic control as one long sustained bout of 45 minutes of walking.¹³

CONCLUSION

Overall, the combined quality of the studies in this review is very low based on the GRADE criteria. Nonetheless, there is little argument against the benefits of physical activity, even at such low intensity as light walking after each meal. As shown by the studies in this review, postprandial walking, even at very low intensity, has demonstrated to be effective in blunting and delaying the rise in post meal glycemic level. Benefits greatly outweigh the risks. First, almost anyone can perform a very light walk 15 minutes after each meal. Normal, light walking does not require special clothing or good running shoes. The activity can be performed indoors. Second, it is possible for people with medical conditions or body habitus who are not very fit for running to perform. Walking puts less stress and strain on muscles and joints. The risk of musculoskeletal injury performing a very light walk is very minimal. Although, there are limitations to both of the studies in this review, there are suggestive evidence to warrant further investigation with a larger, well-designed randomized control trial in order to validate that such low intensity exercise as in walking 15 minutes after each meal can be

recommended to the general population as a preventive measure to lower postprandial hyperglycemia.

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TABLE 1 GRADE Quality Assessment: Crossover studies on postmeal glycemic level after walking

Quality Assessment							Quality
Downgrade Criteria							
<i>Studies</i>	<i>Design</i>	<i>Limitations</i>	<i>Indirectness</i>	<i>Imprecision</i>	<i>Inconsistency</i>	<i>Publication bias likely</i>	
Lunde et al ¹⁰	Crossover	Very Serious limitations*	No serious indirectness	Serious imprecision**	No serious inconsistencies	No bias likely	Very low
DiPietro et al ¹³	Crossover	Very Serious limitations*	No serious indirectness	Serious imprecision**	No serious inconsistencies	No bias likely	Very low

*No blinding and lack of appropriate randomization
 **small sample sizes