Changes in blood flow patterns with participation in a diet and exercise program in adults with pre-diabetes

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ABSTRACT

Background: Pre-diabetes is present in nearly one third of the United States population and is more common in middle-aged and older adults. Older adults are known to exhibit turbulent blood flow patterns that can lead to atherosclerosis. Research suggests exercise training may improve blood flow patterns by increasing antegrade (forward) blood flow rates.

Hypothesis: We tested the hypothesis that blood flow patterns would be improved in middle-aged adults with pre-diabetes after participation in a 12-week diet and exercise lifestyle intervention.

Methods: We measured leg blood flow (Doppler ultrasound) and calculated blood flow shear rates at rest in middle-aged adults with pre-diabetes (n=16, 51±2 years) before and after 12 weeks of participation in a lifestyle intervention.

Results: After 12 weeks, adults with pre-diabetes were more physically active. In addition, participants had a reduction in weight, waist circumference, and blood pressure when compared with the start of the program (p<0.05). Confirming our hypothesis, antegrade (forward) blood flow shear rates increased with participation in a lifestyle intervention (p<0.05).

Conclusion: Participating in a 12-week diet and exercise program improves cardiovascular risk factors and blood flow patterns in middle-aged adults with pre-diabetes. These improvements were seen with only moderate changes in physical activity. This study is the first to suggest adapting a healthy lifestyle can reduce and/or reverse the progression of atherosclerosis in middle-aged adults with pre-diabetes.

DEMOGRAPHICS

Visit 1 Visit 2 Relative Change (%)

Sex (Male/Female) 1/15 1/15
Weight (kg) 106±5 102±5 -3±1
BMI (kg.m-2) 37±2 36±1 -2±1
Waist (cm) 114±4 110±3 -3±1
Glucose (mg.dL-1) 120±9 106±5 -7±5
Total cholesterol (mg.dL-1) 163±11 162±11 -3±3
LDL cholesterol (mg.dL-1) 89±7 94±8 10±15
HDL cholesterol (mg.dL-1) 49±3 48±4 +1±5
Triglycerides (mg.dL-1) 134±13 129±12 -3±13
Systolic BP (mmHg) 128±2 128±2
Diastolic BP (mmHg) 74±1 74±1
Mean BP (mmHg) 92±2 92±2
Heart Rate (beat.min-1) 70±2 69±2

Physical Activity (kcal.wk-1) 942±192 1897±591 +238±123

FIGURE 3: Changes in blood flow (A) and blood flow shear rate (B) after 12 weeks participation in a diet and exercise program

Antegrade (ASR, forward blood flow), Retrograde (RSR, backward blood flow).

* p<0.05 vs Visit 1, † p=0.05 vs No change from Visit 1.

INTRODUCTION AND HYPOTHESIS

Nearly one third of adults in the United States has pre-diabetes. Adults with pre-diabetes exhibit at least three of the following cardiovascular disease risk factors: obesity, high blood pressure, high glucose levels, high triglycerides, low HDL (good) cholesterol.

Adults with pre-diabetes are encouraged to participate in physical activity to prevent the progression toward cardiovascular disease. Lifestyle interventions incorporate increases in physical activity and healthy eating in adults with pre-diabetes that result in improved weight, blood pressure, and glucose levels. Participation in such programs can reduce a person’s risk of developing diabetes by 50%.

Older adults are known to exhibit turbulent blood flow patterns that can induce atherosclerosis. Research suggests exercise training may slow down or reverse vessel plaque formation by increasing antegrade (forward) blood flow rates. Until now, no studies have tested whether physical activity and diet can improve blood flow patterns that might delay or reduce the development of atherosclerosis and cardiovascular disease.

METHODS

Diet and Exercise Program

• Each patient was diagnosed by their physician as having pre-diabetes.
• Patients enrolled themselves in the ALL Program or were referred by their doctor.

For 12 weeks, patients met weekly for one hour of education and one hour of supervised group exercise. Patients completed food records and exercise log each week that were reviewed by ALL Program staff.

• Participants in the current study were recruited from the ALL Program and represent a subset of these patients.

Research Participants

• 16 participants (15 females, 1 male) in the ALL Program.
• Each participant completed 2 study visits: at the introduction to the program (Visit 1), after 12 weeks of participation (Visit 2).

CONCLUSIONS

Participating in a 12-week lifestyle intervention improves cardiovascular risk factors and blood flow patterns in middle-aged adults with pre-diabetes. Specifically, participation increased resting leg blood flow and antegrade shear rate. These improvements were seen with only moderate changes in physical activity.

This study is the first to suggest adapting a healthy lifestyle can improve blood flow patterns that may be important for reducing and/or reversing the progression of atherosclerosis and cardiovascular disease in middle-aged adults with pre-diabetes.

SUMMARY OF RESULTS

After 12 weeks of participation in the diet and exercise program, we observed:

1) A ~200% increase in physical activity in adults with pre-diabetes.
2) A significant reduction in weight, waist circumference, and blood pressure.
3) A relative increase in resting blood flow and vascular conductance in the leg.
4) A relative increase in antegrade (forward) blood flow rate in the femoral artery.

Previous research suggests increased blood flow, increased antegrade shear rates, and decreased oscillatory shear can improve glucose and blood pressure levels, in addition to decreasing atherosclerosis.

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