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Randomized Control Trials

Effects of diet-induced weight loss on postprandial vascular function after consumption of a mixed meal: Results of a randomized controlled trial with abdominally obese men

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Summary

Background: Effects of weight loss on postprandial vascular function have not been studied so far. We therefore examined (i) effects of diet-induced weight loss on postprandial changes in various vascular function markers after consumption of a mixed meal and (ii) differences between normal-weight and abdominally obese men of comparable age at baseline and after weight loss.

Methods: Fifty-four apparently healthy abdominally obese (waist circumference: 102–110 cm) and 25 normal-weight men (waist circumference: <94 cm) participated. The abdominally obese men were randomly allocated to a diet-induced weight-loss program or a no-weight loss control group. Men assigned to the weight-loss program followed a calorie-restricted diet for six weeks targeting a waist circumference of less than 102 cm, followed by a weight-maintenance period for two weeks. The control group maintained their habitual diet and physical activity levels. Measurements were performed before and two hours after consumption of the test meal consisting of two muffins (containing 56.6 g fat) and 300 mL low-fat milk.

Results: The mean weight loss was 10.3 kg in the weight-loss compared with the control group. The postprandial change in flow-mediated vasodilation of the brachial artery (FMD) was significantly higher at baseline in normal-weight as compared with the postprandial change in abdominally obese men (1.89 ± 2.52 versus 0.48 ± 2.50 percentage points; P = 0.027). However, no differences in postprandial changes were observed in the abdominally obese men after weight loss compared with the control treatment. Also, weight reduction did not affect postprandial changes in carotid-to-femoral pulse wave velocity, retinal microvascular caliber properties, or plasma markers of microvascular endothelial function. Even though postprandial increases in triacylglycerol (P = 0.028), insulin (P = 0.029) and C-peptide concentrations (P < 0.001) were reduced in the abdominally obese men following weight loss, postprandial changes in FMD at the end of the weight-loss treatment were still more unfavorable as compared with those observed in normal-weight individuals.

Conclusion: In this trial with abdominally obese men, we did not find effects of diet-induced weight loss on postprandial changes in vascular endothelial function, arterial stiffness and markers of microvascular function. This trial was registered on ClinicalTrials.gov under study number NCT01675401.

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1. Introduction

Strong and consistent evidence links abdominal obesity to many cardiometabolic disorders, including dyslipidemia, impaired glucose tolerance, hypertension and low-grade systemic inflammation [1].
All these disorders are associated with disturbed vascular homeostasis [2], which predicts the longer-term risk for atherosclerotic plaque development and cardiovascular disease (CVD) [3,4]. We [5] and others [6–9] have earlier reported that in abdominally obese men diet-induced weight reduction not only significantly improved the cardiometabolic risk profile, but also fasting vascular function [5]. However, effects of weight loss on postprandial vascular function markers have hardly been studied. Results, however, are difficult to interpret as no-weight loss control groups were missing [10,11]. Effects of weight loss are of particular interest, as abdominally obese adults have disturbed postprandial cardiometabolic responses that may contribute to the development of CVD [12]. Since we spend most of the time of the day in the postprandial state, examining differences in postprandial vascular function may be important in understanding the pathogenesis of the increased cardiovascular risk associated with abdominal obesity. Also, repeated changes in vascular function caused by meal consumption may affect the risk to develop CVD [13], and identifying prevention strategies to improve postprandial vascular function may be of major importance to decrease longer-term risk of CVD. Furthermore, a high-fat meal may transiently impair vascular function [14,15], possibly through increased oxidative stress and inflammatory responses that reduce the bioavailability of nitric oxide (NO) [16]. These postprandial challenges may identify subtle changes in vascular function following lifestyle interventions. Therefore, the objective of the current randomized controlled trial (RCT) with a no-weight loss control group was to investigate (i) effects of diet-induced weight loss on postprandial changes in markers of endothelial function, arterial stiffness and microvascular function after consumption of a mixed meal and (ii) differences between normal-weight and abdominally obese men of comparable age at baseline and after weight loss.

2. Participants and methods

2.1. Participants and study design

Caucasian, normal-weight men (waist circumference: <94 cm) and abdominally obese men (waist circumference: 102–110 cm) participated in the present intervention trial. Details have been published before [5]. Briefly, abdominally obese men were randomly allocated to a diet-induced weight-loss or a no-weight loss control group. Individuals from the weight-loss group consumed for four to five weeks under strict guidance a very low-calorie diet (VLCD) (Modifast; Nutrition et Santé Benelux, Breda, The Netherlands) targeting a waist circumference of less than 102 cm. The value of 102 cm was chosen because it is used as cut-off value in the diagnosis of the metabolic syndrome [17]. The protein-rich VLCD provided daily 2.1 MJ (500 kcal), while the vitamin and mineral content met the Dutch recommended daily intakes. The VLCD was supplied in powder sachets that had to be dissolved in water to obtain a milkshake, pudding or muesli. Individuals were then prescribed a mixed solid calorie-restricted diet in agreement with the Dutch dietary guidelines. This diet provided daily 4.2 MJ (1000 kcal) for a period of one to two weeks and consisted of the three main meals. In week seven and eight, the participants were kept in energy balance (weight-maintenance period) by prescribing detailed weekly menus that were based on an individual’s estimated energy requirements for weight maintenance [18]. Men assigned to the control group maintained their habitual diet, physical activity levels and use of alcohol throughout the total study period. Inclusion and exclusion criteria have been published before [5]. In brief, all study volunteers were apparently healthy and did not receive anti-hypertensive medication or drugs known to affect serum lipid or plasma glucose metabolism. Twenty-five normal-weight and 54 abdominally obese men with an age between 18 and 65 years were included. They had a stable body weight (weight change < 3 kg within the previous three months), fasting serum triacylglycerol concentrations ≤ 4.5 mmol/L, and no indications for treatment with cholesterol-lowering medications [19]. All participants gave written informed consent before entering the study. The current study was approved by the Ethics Committee of Maastricht University Medical Center (METC123040), and registered on August 21st, 2012 at ClinicalTrials.gov as NCT01675401.

A postprandial test was performed at baseline and at the end of the intervention period. On the day preceding testing, men were asked not to consume high-fat foods or alcohol or to perform any strenuous physical exercise. After an overnight fast (no food or drink after 08.00 PM, except for water), volunteers arrived at the research facilities by public transport or by car to standardize measurements as much as possible. After an acclimatization period of 30 min in the supine position, fasting blood pressure and vascular function measurements were performed. After an intravenous cannula was inserted into a vein and a fasting venous blood sample (T0) was drawn, men had to consume within ten minutes a standardized mixed meal. Subsequent blood samples were collected 15 min (T15), 30 min (T30), 45 min (T45), 60 min (T60), 90 min (T90), 120 min (T120), 180 min (T180), and 240 min (T240) after meal consumption. After each blood sample, the intravenous catheter was rinsed with 1 ml 1% heparin (LEO Pharma, Ballerup, Denmark) in 0.9% NaCl. Clinical measurements were repeated two hours after meal consumption, immediately after taking the T120 blood sample.

2.2. Test meal

The test meal (Supplemental Table 1) consisted of two muffins (providing 56.6 g of dietary fat) and 300 ml low-fat milk (0% fat milk; Friesland-Campina, Woerden, The Netherlands). The mixed meal (fat/carbohydrate/protein: 46.6 En%/44.0 En%/9.6 En%) had an energy content of 1100 kcal and provided 26.5 g protein, 121.0 g carbohydrates and 56.6 g fat (fatty acid composition: 33.9 g saturated fatty acids, 2.2 g trans fatty acids, 14.5 g monounsaturated fatty acids, and 2.7 g polyunsaturated fatty acids). One batch of muffins was made for the entire study by a dietician. After baking the muffins at 180 °C in a fan-assisted oven for 20 min and cooling down, the muffins were portion-packed and frozen at −20 °C.

2.3. Clinical measurements

Blood pressure and vascular function measurements were performed in a quiet and darkened room that was temperature controlled at 24 °C. Procedures have been described before [5]. In brief, blood pressure was measured in the supine position using a semi-continuous blood pressure monitoring device (Omron Intelisense M7; Cemex Medische Techniek, Nieuwegein, The Netherlands). The first measurement was discarded and the average of the last three measurements was reported. Pulse wave analysis (PWA) was performed, in triplicate, with a tonometer (SphygmoCor v9; ATCor Medical, West Ryde, Australia) applied to the radial artery. The central arterial waveform was derived from the peripheral arterial waveform using a validated transfer function. Central augmentation indices were determined and corrected for heart rate (CAXH/R75). With use of the direct carotid to femoral distance, carotid-to-femoral pulse wave velocity (PWV C-F) was determined [20] in triplicate, using the same tonometer. Flow-mediated vasodilation of the brachial artery (FMD) was assessed by ultrasound echography in dual mode (MyLab™70; Esaote, Maastricht, The Netherlands) and recording of echo images on DVD.
Reactive hyperemia was induced by forearm occlusion through inflation of a cuff to 200 mmHg for five minutes. The echo images were analyzed offline using a custom-written Matlab program (MyFMD; Prof. A.P. Hoeks, Department of Biomedical Engineering, Maastricht University Medical Center, Maastricht, The Netherlands). The FMD response was quantified as the maximal percentage change in post occlusion arterial diameter relative to baseline diameter. During brachial artery FMD measurements, the Endo-PAT 2000 (Itamar Medical Ltd, Caesarea, Israel) was used to measure changes in pulse wave amplitude using finger arterial tonometry. Reactive Hyperemia Index (RHI) was quantified as the post-to-pre occlusion peripheral arterial tone signal ratio in the occluded hand, normalized to the values in the control hand and then further corrected for baseline vascular tone [22]. Finally, retinal vascular images were obtained using a retinal camera (Topcon TRC-NW-300; Topcon Co., Tokyo, Japan) to assess microvascular diameters in the eye. Images were digitized and analyzed to calculate the central retinal arteriolar equivalent (CRAE), central retinal venular equivalent (CRVE) and arteriolar-to-venular diameter ratio (AVR) with appropriate software (Generalized Dual-Bootstrap Iterative Closest Point [GDBP-ICP]) [23]. At least two arteriolar and two venular retinal calibers were determined and standardized by using the Parr-Hubbard formulas [24].

### 2.4. Blood analyses

After blood sampling, NaF-containing vacutainer tubes (Becton, Dickinson and Company, Franklin Lakes, NY, USA) and EDTA-coated vacutainer tubes (Becton, Dickinson and Company) were kept on ice and centrifuged within 30 min at 1300 × g for 15 min at 4 °C to obtain plasma. Blood drawn in vacutainer serum tubes (Becton, Dickinson and Company) was allowed to clot for at least 30 min at 21 °C. To obtain serum, tubes were centrifuged at 1300 × g for 15 min at 21 °C. Following centrifugation, samples were immediately portioned into aliquots and stored at −80 °C until analysis at the end of the study.

Plasma glucose (Horiba ABX, Montpellier, France) concentrations were measured in NaF-plasma at all time points, and those of insulin and C-peptide (RIA; Millipore, Billerica, MA, USA) in all serum samples. Serum triacylglycerol (GPO Trinder; Sigma–Aldrich Corp., St. Louis, MO, USA) with correction for free glycerol was measured hourly. Furthermore, EDTA-plasma samples collected at T0, T120 and T240 were used for measurement of markers of low-grade systemic inflammation (interleukin [IL]-6, IL-8, tumor necrosis factor [TNF]-α, C-reactive protein [CRP], serum amyloid A [SAA]) and markers of microvascular endothelial function (soluble vascular cell adhesion molecule [sVCAM]-1, soluble intercellular adhesion molecule [sICAM]-1, soluble endothelial selectin [sE-selectin]) by using a multi-array detection system based on electro-chemiluminescence technology (SECTOR Imager 2400; Meso Scale Discovery, Rockville, MD, USA). Von Willebrand factor (vWF) was assessed by ELISA in citrate plasma at T0, T120 and T240, as described [25].

### 2.5. Statistical analyses

Results are presented as means ± standard deviations (SDs), unless otherwise indicated. A per-protocol analysis was performed as the objective was to investigate effects of weight loss on postprandial vascular function. However, intention-to-treat analysis was also performed by using the last observation carried forward approach for the primary outcome (FMD), which was used for the power calculation before the start of the study [26]. Postprandial changes between fasting and postprandial values were calculated. For serum triacylglycerol, plasma glucose, serum insulin and serum C-peptide, the area under the curve (AUC) and the incremental area under the curve (iAUC; the area above baseline [T0] concentrations) over the postprandial period were calculated using the trapezoidal rule [27]. Maximal increases in concentrations were calculated by subtracting baseline values from maximal values. An independent Student’s t test was used to examine differences at baseline between normal-weight and abdominally obese men. A one-way ANCOVA, using baseline measurements as covariates, was performed to evaluate differences in changes between weight-loss and no-weight loss control treatments. Postprandial changes in circulating markers were analyzed using linear mixed models with treatment and time as fixed factors and with posttreatment as an interaction term. If the interaction term was not significant, it was omitted from the model. For this, the postprandial curve obtained at follow-up was first subtracted from the postprandial curve at baseline. Correlation coefficients were determined to investigate the relation between postprandial changes in vascular function markers following weight loss and postprandial changes in lipemic and glycemic responses. Differences were considered significant at P < 0.05. All statistical analyses were performed using SPSS 23.0 (SPSS Inc, Chicago, IL, USA).

### 3. Results

#### 3.1. Study participants

A Consolidated Standards of Reporting Trials (CONSORT) flow diagram through the intervention trial is depicted in Supplemental Fig. 1. Twenty-five normal-weight and 53 abdominally obese participants completed the baseline measurements. The abdominally obese men were randomized to a diet-induced weight-loss group or a no-weight loss control group, and 50 men completed the weight-loss study. One of the participants from the weight-loss group was excluded from the analyses due to protocol violations. Baseline characteristics of the participants have been described before [5]. In brief, the median age was comparable between the normal-weight and abdominally obese men. The waist circumference (84.9 ± 6.3 cm versus 106.5 ± 3.6 cm), BMI (23.3 ± 1.8 kg/m² versus 30.1 ± 2.1 kg/m²), waist-to-hip ratio (0.88 ± 0.05 versus 0.99 ± 0.04) and calculated body fat (18.7 ± 5.2% versus 28.0 ± 3.5%) were higher in the abdominally obese men (P < 0.001 for all variables). The mean weight reduction was 10.3 kg (95% CI: 9.2–11.4 kg; P < 0.001) after the weight-loss treatment, while body weight remained stable during the weight-maintenance period (0.3 ± 0.9 kg). The waist circumference was reduced by 11.0 cm (95% CI: 9.9–12.1 cm; P < 0.001) and body fat was decreased by 4.0 percentage points (pp) (95% CI: 3.2 to 4.8 pp; P < 0.001). Except for two men, men from the weight-loss group obtained a waist circumference below the cut-off value of 102 cm.

#### 3.2. Postprandial vascular function and blood pressure

At baseline, FMD was significantly increased from fasting values following mixed-meal consumption in normal-weight individuals, but did not change in the abdominally obese men (Table 1). In fact, the postprandial change in FMD was higher in normal-weight as compared with abdominally obese men (1.89 ± 2.52 pp versus 0.48 ± 2.50 pp; P = 0.027), but did not differ in the abdominally obese men after weight loss compared with the control treatment (0.87 pp; 95% CI: −0.87 to 2.61 pp; P = 0.32). An intention-to-treat analysis showed comparable effects. Postprandial decreases in CAIXHR75 were comparable between normal-weight and abdominally obese men at baseline, but were less pronounced in the abdominally obese men after weight loss compared with those observed in the control group (P = 0.016). As shown in Table 1, no

![Image of a page from a document](https://example.com/image.png)
differences were observed in postprandial changes in baseline brachial artery diameters, RHI, PWV_{c-f} and retinal microvascular calibers.

Figure 1 depicts effects (i.e. PWV_{c-f}, carotid-to-femoral pulse wave velocity; SBP: systolic BP; DBP: diastolic BP; PP: pulse pressure; BPM: mean arterial pressure; BPM: beats per minute).

The effects of a mixed meal on postprandial blood pressure levels are shown in Table 1. Except for brachial SBP, significant postprandial changes were observed in brachial DBP, central DBP, brachial PP, MAP, central SBP and heart rate (P < 0.01 for all variables). At baseline, no differences were found between abdominally obese and normal-weight individuals. However, postprandial decreases in brachial and central DBP slightly improved after diet-induced weight loss compared with the control treatment by 2.4 mmHg (95% CI: 0.1–4.7 mmHg; P = 0.040) and 2.7 mmHg (95% CI: 0.4–5.0 mmHg; P = 0.024), respectively (see Table 1).

3.3. Postprandial lipemic and glycemic responses

The iAUC of serum triacylglycerol over the postprandial period tended to differ (P = 0.072) at baseline between the normal-weight and abdominally obese men, while the iAUCs of glucose, insulin and C-peptide were lower in normal-weight individuals (P < 0.05 for all variables) (Table 2). Postprandial changes (iAUCs, AUCs and maximal increases) for all these variables, except for the iAUC and the maximal increase in plasma glucose concentrations, were improved in the abdominally obese men after weight loss compared with the control treatment (P < 0.01 for all variables) (Table 2). Moreover, postprandial changes in CAxHR75 following weight loss were significantly related to improvements in maximal increases, and the AUC and iAUC during the first two and four hours for serum insulin. Correlations between postprandial changes in other vascular function markers following weight loss and changes in postprandial lipemic and glycemic responses did not reach significance. Linear mixed model analyses showed comparable effects. Postprandial increases in triacylglycerol (P = 0.028), insulin (P = 0.029) and C-peptide concentrations (P < 0.001) were less pronounced in the abdominally obese men after weight loss compared with the control treatment, but increases in glucose concentrations did not differ (P = 0.47). Finally, postprandial lipemic, insulinenic and C-peptidemic responses after intake of a mixed-meal became comparable in the abdominally obese men at the end of the weight-loss treatment compared to those of the normal-weight individuals.

4. Discussion

This is the first RCT with a no-weight loss control group that assessed the effect of diet-induced weight loss on postprandial FMD responses. For this, study participants received a standardized mixed meal with 300 mL low-fat milk, which was deliberately chosen to mirror closely the postprandial response observed in real life. However, diet-induced weight reduction did not modify the postprandial change in FMD, even though the expected decreases in postprandial lipemic and glycemic responses, which may...
the postprandial curve at baseline.

mixed meal at baseline, and after an 8-week diet-induced weight-loss (###)

weight-loss or no-weight loss control treatment in a randomized controlled trial with abdominally obese men (a).

* Significantly different from abdominally obese participants (independent Student's t test): *P < 0.05, **P < 0.01, ***P < 0.001; # Treatment effect (one-factor ANCOVA with baseline value as covariate): **P < 0.01, ***P < 0.001.

Postprandial lipemic and glycemic responses after consumption of a mixed meal in normal-weight and abdominally obese men at baseline, and after an 8-week diet-induced weight-loss or no-weight loss control treatment in a randomized controlled trial with abdominally obese men.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Normal-weight group</th>
<th>Diet-induced weight-loss group</th>
<th>No-weight loss control group</th>
<th>Treatment effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Follow-up</td>
<td>Baseline</td>
<td>Follow-up</td>
</tr>
<tr>
<td>TAG (mmol·min/L)</td>
<td>120 ± 48</td>
<td>136 ± 55</td>
<td>110 ± 58</td>
<td>168 ± 99</td>
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<tr>
<td>AUC (mmol·min/L)</td>
<td>361 ± 140***</td>
<td>526 ± 238</td>
<td>395 ± 176</td>
<td>615 ± 253</td>
</tr>
<tr>
<td>max increase (mmol/L)</td>
<td>2.48 ± 0.92</td>
<td>2.81 ± 1.32</td>
<td>1.13 ± 0.61</td>
<td>3.44 ± 1.94</td>
</tr>
<tr>
<td>Glucose (mmol·min/L)</td>
<td>166 ± 107*</td>
<td>209 ± 137</td>
<td>150 ± 98</td>
<td>272 ± 156</td>
</tr>
<tr>
<td>AUC (mmol·min/L)</td>
<td>1381 ± 164**</td>
<td>1467 ± 182</td>
<td>1349 ± 150</td>
<td>1608 ± 203</td>
</tr>
<tr>
<td>max increase (mmol/L)</td>
<td>4.69 ± 0.90</td>
<td>4.53 ± 1.39</td>
<td>1.68 ± 0.69</td>
<td>5.49 ± 2.04</td>
</tr>
<tr>
<td>Insulin (μU·min/mL)</td>
<td>6861 ± 3512****</td>
<td>11,545 ± 5754</td>
<td>6712 ± 2864</td>
<td>13,607 ± 7221</td>
</tr>
<tr>
<td>max increase (μU/mL)</td>
<td>8573 ± 3638***</td>
<td>14,231 ± 6366</td>
<td>8475 ± 3444</td>
<td>16,374 ± 8153</td>
</tr>
<tr>
<td>C-peptide (μg·min/mL)</td>
<td>154 ± 64**</td>
<td>206 ± 95</td>
<td>69 ± 30</td>
<td>229 ± 114</td>
</tr>
<tr>
<td>AUC (ng·min/mL)</td>
<td>677 ± 227***</td>
<td>931 ± 323</td>
<td>685 ± 258</td>
<td>1026 ± 301</td>
</tr>
<tr>
<td>max increase (ng/mL)</td>
<td>906 ± 264***</td>
<td>1312 ± 406</td>
<td>985 ± 342</td>
<td>1445 ± 410</td>
</tr>
</tbody>
</table>

Values are means ± SD.

* Values are mean changes (95% CI) obtained from one-factor ANCOVA with baseline value as covariate.
improve postprandial FMD responses, were observed. In fact, other studies have reported a negative correlation between the magnitude of lipemia [28,29] or glycemia [30,31] with the change in FMD. However, like several other studies [32–34], these correlations did not reach statistical significance in our study. Differences in meal composition and experimental design may explain some of the discrepancies between studies. Actually, it should be noted that we did not observe a decrease in FMD at all in the abdominally obese men after meal intake. In contrast, earlier we have reported in healthy overweight and slightly obese men an impairment in FMD two hours after consumption of a mixed meal [16], which was improved after consumption of 140 mL concentrated beetroot juice [16]. In the current study, FMD was also measured two hours after meal intake, but low-fat milk was now part of the standardized mixed meal. Westphal and colleagues have earlier reported that the postprandial impairment in FMD was not observed when (milk) proteins were added to their meal providing 30% whipping cream [35]. As compared to our mixed meal, their standardized meal had a lower energy content of about 860 kcal and provided more protein (~55 g) and less carbohydrates (~7 g). Effects on FMD were explained by the increased supply of the amino acid L-arginine, which is a substrate for endothelial NO synthase (eNOS) [35]. Interestingly, postprandial FMD changes at baseline were more favorable in the normal-weight men than in the abdominally obese men. Differences in postprandial lipemic and glycemic responses cannot explain these results. Even though these responses became very comparable at the end of the weight-loss period, changes in FMD were still significantly different. Alternatively, beneficial effects of L-arginine on the postprandial change in FMD may be more pronounced in normal-weight participants. These individuals have a higher eNOS protein content, which was inversely related to BMI [36], and thus increased capacity for NO production [36]. Even if weight loss was substantial, men in our study still had a BMI above 25 kg/m² and a waist circumference slightly less than 102 cm, which was substantially higher than the values for the normal weight-men. In contrast, Ayer and colleagues observed no differences in postprandial FMD changes to a high-fat meal challenge between obese and normal-weight adults [37]. However, a main difference was the amount of protein in the test meal, which was higher in our study. Similar results were found for the RHI reflecting small artery reactivity, while FMD evaluates a large conduit artery. These findings indicate that besides the lack of an effect on peripheral muscular arteries, weight reduction does also not affect postprandial artery reactivity obtained at the fingertips. Lastly, a potential limitation is that we did not monitor cardiorespiratory fitness in the present study. Therefore, we cannot exclude that differences in fitness levels between normal-weight and abdominally obese men at baseline and/or after weight loss might have affected our results.

The postprandial PWVc-f [38] response was not affected by diet-induced weight loss. To the best of our knowledge, no other trials have assessed effects of weight reduction on postprandial arterial stiffness. However, postprandial changes in the CAIxHR75, which depends on the tone of peripheral resistance arteries, increased by 3.8 pp. Earlier, we already observed postprandial decreases in CAIxHR75 that were related to postprandial insulin responses [16], which induces peripheral vasodilation via fast endothelial-independent mechanisms [39]. Interestingly, we also observed a correlation between postprandial changes in CAIxHR75 following weight reduction with improvements with the AUC, iAUC and maximal increases in serum insulin concentrations. However, even though a higher fasting CAIxHR75 was associated with a higher risk of CVD [40], it is not known whether differences in the frequent, but transient, postprandial decreases in CAIxHR75 are of clinical importance for longer-term CVD risk. In contrast, postprandial changes in DBP decreased in the diet-induced weight loss group compared with the control group, but were not related to postprandial insulin responses. However, meal intake also involves other vascular mechanisms that affect especially postprandial blood pressure levels [39], such as a decreased blood flow in peripheral muscles [39].

Baseline brachial artery diameters after meal intake were not affected. An endothelium-independent vasodilator effect of a meal on the brachial artery diameters would result in a reduced FMD from fasting values [41,42]. However, since no differences in diameters were observed, this could not explain our results. Finally, specific effects of weight loss on postprandial microvascular calibers in retina were addressed, but no treatment effects were observed. Diet-induced weight loss also did not affect postprandial markers of microvascular endothelial function and low-grade systemic inflammation, which has never been investigated before.

In conclusion, our data indicate that in abdominally obese men diet-induced weight loss did not affect postprandial endothelial function, arterial stiffness, retinal microvascular calibers and plasma markers of microvascular endothelial function after consumption of a mixed meal. Although postprandial lipemic and glycemic responses improved in the abdominally obese men following weight loss, postprandial changes in vascular function at the end of the 8-week weight-loss program were still more unfavorable as compared to those observed in normal-weight men.

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Authorship

P.J.J., J.P., Y.H.K., A.J.H., C.D.S., C.G.S., and R.P.M. designed the study and also interpreted the results. P.J.J. and Y.H.K. conducted the study and P.J.J. performed the statistical analyses. P.J.J. and R.P.M. drafted the first version of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

None of the authors had any financial or personal conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnu.2020.01.006.

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