Differences in Weight Loss Between Persons on Standard Balanced vs Nutrigenetic Diets in a Randomized Controlled Trial

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This article has an accompanying continuing medical education activity on page e145. Learning Objective–Upon completion of this activity, successful learners will be able to recommend evidence-based advice on nutrigenetic screening and personalized medicine to patients who are trying to lose weight.

BACKGROUND & AIMS: **Many companies provide genetic tests for obesity-related polymorphisms (nutrigenetics) and make dietary recommendations for weight loss that are based on the results. We performed a randomized controlled trial to determine whether more participants who followed a nutrigenetic-guided diet lost ≥5% of their body weight than participants on a standard balanced diet for 8 and 24 weeks.**

METHODS: **We performed a prospective study of 51 obese or overweight U.S. veterans on an established weight management program at the Veterans Administration San Diego Healthcare System (the MOVE! program). Participants were randomly assigned to groups placed on a nutrigenetic-guided diet (balanced, low-carbohydrate, low-fat, or Mediterranean; n = 30) or a standard balanced diet (n = 21). Nutrigenetic diets were selected on the basis of results from the Pathway FIT test.**

RESULTS: **There was no significant difference in the percentage of participants on the balanced diet vs the nutrigenetic-guided diet who lost 5% of their body weight at 8 weeks (35.0% ± 20.9% vs 26.9% ± 17.1%, respectively; $P = .28$) or at 24 weeks. Both groups had difficulty adhering to the diets. However, adherence to the nutrigenetic-guided diet correlated with weight loss ($r = 0.74$; $P = 4.0 \times 10^{-5}$), but not adherence to standard therapy ($r = 0.34$; $P = .23$). Participants who had low-risk polymorphisms for obesity lost more weight than all other participants at 8 weeks (5.0% vs 2.9%, respectively; $P = .02$) and had significantly greater reductions in body mass index (6.4% vs 3.6%, respectively; $P = .03$) and waist circumference (6.5% vs 2.6%, respectively; $P = .02$) at 24 weeks.**

CONCLUSIONS: **In a prospective study, a nutrigenetic-based diet did not increase weight loss compared with a standard balanced diet. However, genetic features can identify individuals most likely to benefit from a balanced diet weight loss strategy; these findings require further investigation. ClinicalTrials.gov number: NCT01859403.**

Keywords: BMI; Nutrigenomics; Diet; Personalized Medicine.

More than one-third (34.9%) of the U.S. adult population is obese,[1] and it is estimated to cost $147 billion to the healthcare system annually.[2] However, there is a lack of effective, sustainable, nonsurgical treatments of obesity.[3] This difficulty is in part due to the multi-genetic nature of obesity, where heritable factors can provide up to 70% of the estimated risk in some individuals.[4] Although genome-wide association studies have led to the identification of at least 32 gene loci associated with obesity,[5–9] whether an individual's genetic profile can play a role in personalized obesity therapy is still unknown.

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Abbreviations used in this paper: BDG, balanced diet genotype; BMI, body mass index; GT, genotype-guided therapy; ST, standard therapy.

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Nevertheless, many U.S. and European companies provide targeted genetic testing for obesity-related polymorphisms and make dietary and other intervention recommendations on the basis of their results. These tests are often marketed directly to patients and can range in cost from approximately $100 to $1000.[10,11] Published data on the use and market of nutrigenetic testing are sparse; however, direct-to-consumer genetic testing is a growing industry, which is projected to reach $233 million by 2018.[12] Although there are questions about the usefulness of these tests in patient care,[11] there is also potential in improving and individualizing therapy in obesity and, as a result, decreasing overall healthcare costs.[13]

Several observational studies have shown that those with high-risk polymorphisms of a few specific genes have improved weight loss or metabolic profiles by changing to a particular diet (eg, low-fat diet, Mediterranean diet).[14–21] Specifically, the negative consequences associated with the high-risk polymorphisms in these 7 genes can be mitigated by a change in diet: apolipoprotein A-II gene (APOA2),[18,22] adiponectin gene (ADIPOQ),[19,23,24] fat mass and obesity-associated protein gene (FTO),[17,25,26] potassium channel tetramerization domain containing 10 gene (KCTD10),[21] hepatic triglyceride lipase gene (LIPC),[16,27] methylmalonicaciduria (cobalamin deficiency) cblB type gene (MMAB),[21] and peroxisome proliferator-activated receptor gamma gene (PPARG)[20,28] (Supplementary Table 1). Still, evidence to support a strategy of nutrigenetic-guided weight loss intervention is limited.

In this prospective, randomized, controlled clinical trial, participants' genetic profiles were used to provide a personalized diet recommendation to see whether education and support for the genetic-based diet would improve weight loss and metabolic measurements compared with standard therapy in an established weight management program. This is a feasibility study to determine whether it would be fruitful to implement this strategy and its potential efficacy. The main objective was to determine whether more participants in the genetics-guided therapy (GT) group lost $\geq$5% of their weight after 8 weeks compared with those in the standard therapy (ST) group. The secondary objectives were to evaluate whether more GT participants lost $\geq$5% of their weight after 24 weeks.

Methods

The Supplementary Materials and Methods section describes the full details of the clinical trial including methodology, patient eligibility, measures taken, and statistical analysis.

In brief, the study was a prospective, randomized, controlled feasibility trial of an 8-week diet counseling intervention for veterans enrolled in the MOVE! program with continued assessment to week 24 between November 2012 and March 2014. The MOVE! program is an 8-week, evidence-based weight management program for overweight and obese veterans that is established in all Veterans Administration hospitals.[29] This study received institutional review board approval (protocol # H130174). It was also registered with ClinicalTrials.gov (NCT01859403). All authors had access to the study data and had reviewed and approved the final manuscript.

Veterans with a physician's referral to weight management clinic and a body mass index (BMI) $\geq$30.0 kg/m^2 were recruited from those enrolled in the Veterans Administration San Diego Healthcare System's MOVE! program. Participants entered the study on their normal diet. The baseline visit was 3–4 weeks before start of MOVE! program initiation. After baseline measurements were taken, participants provided saliva for genetic analysis (Pathway Genomics, Inc, San Diego, CA) (Supplementary Figure 1). Participants were then randomly assigned to either the GT group or ST group. Randomization, which was performed before receipt of nutrigenetic report, was non-stratified, two-group, concealed allocation by using the Research Randomizer website.[30]

In the GT group, participants and researchers were unblinded to the diet match, and participants were informed of their nutrigenetic report. GT participants were matched to 1 of 4 possible diet types: balanced, low-carbohydrate, low-fat, or Mediterranean on the basis of their report. They received a meal plan, lists of foods to incorporate in the plan, and samples of menus (similar to the MOVE! packet of literature given to ST group) to assist adherence to their diet and to obtain their caloric goal (Supplementary Meal Plan). The macronutrient guidelines of the different diets for the GT participants are shown in Supplementary Table 2. The macronutrient composition of each diet plan was based on a compilation of research studies that showed the benefit of that particular diet plan on patients with a high-risk polymorphism. For example, the macronutrient composition of the Mediterranean diet plan was based on references 17, 19, 23–26 (Supplementary Table 1).

In the ST group, participants and researchers were blinded to the nutrigenetic report. These participants were given the balanced diet plan. The ST group were provided similar education and resources as the GT group for the balanced diet plan and provided the same amount of educational time as those in the GT group. To aid in simplicity and adherence, all diet plans (for both ST and GT participants) incorporated Healthy Choice (ConAgra Foods, Inc, Omaha, NE) entrees at lunch and dinner (Supplementary Sample Menu) for the first 8 weeks of the study, for which participants were fully reimbursed on delivery of receipts. At the conclusion of the study, ST participants were provided their nutrigenetic reports.

Salivary samples from participants were sent to Pathway Genomics, and the Pathway Fit Test (a genomic array) was performed. On the basis of the SNP alleles for 7 genes and by using a proprietary algorithm, the Pathway Fit Test made a recommendation to a specific

diet (Supplementary Figure 1). The genes (and reference SNP [rs] number) used to make these dietary recommendations were APOA2 (rs5082), ADIPOQ (rs17300539), FTO (rs9939609), KCTD10 (rs10850219), LIPC (rs1800588), MMAB (rs2241201), and PPARG (rs1801282) (Supplementary Table 1).

Results

Primary Outcomes

A total of 51 participants were randomized. At the end of 8 weeks, 46 participants remained enrolled in the study. At the end of 24 weeks, 32 participants completed the study; 14 were from the ST group, and 18 were from the GT group (Supplementary Figure 2). Baseline characteristics were similar between the GT and the ST groups (Table 1). The trial ended once the target number of participants was recruited.

In the primary comparison, there was no significant difference between the GT and ST groups in percentage achieving the 5% weight loss at 8 weeks (26.9% ± 17.1% vs 35.0% ± 20.9%, $P = .28$ for GT and ST, respectively; difference in proportion 8.1% with confidence interval of −17.5% to 33.5%) (Figure 1*A*, Table 2). There was also no significant difference in proportion achieving 5% weight loss at 24 weeks (38.9% ± 22.5% vs 35.7% ± 25.1%, $P = .77$; difference in proportion 3.2% with confidence interval of −32.1% to 36.3%) (Figure 1*A*, Table 2). In addition, there was no significant difference in the relative amount of percent weight lost by participants in the study between the GT and ST groups (3.2% ± 0.6% vs 4.0% ± 0.7%, $P = .36$, at 8 weeks and 4.3% ± 1.1% vs 4.4% ± 1.3%, $P = .93$, at 24 weeks, respectively) (Figure 1*B*, Table 2). Notably, observed results of both groups were better than previously published results of the MOVE! program (~15%–20%).[31]

Post Hoc Analyses

Because there were no differences in the primary objective of the study, we investigated whether the GT group had improvements in biomarkers of metabolic disease associated with obesity. However, no differences were found in the lipid profile or glucose homeostasis in

Table 1. Baseline Characteristics of Participants in the Study

	GT	ST	*P* value
Participants (n)	26	20	
Demographics			
Female, n (%)	10 (38)	3 (15)	.08
Age (*y*)	48.4 ± 2.6	54.6 ± 2.7	.11
Latino, n (%)	7 (27)	4 (20)	.73
African American, n (%)	5 (19)	3 (15)	.99
Asian American, n (%)	2 (8)	0 (0)	.50
White, n (%)	12 (46)	13 (65)	.24
Genotype diet recommendation			
Balanced diet, n (%)	6 (23)	8 (40)	.33
Low-fat diet, n (%)	15 (58)	10 (50)	.77
Low-carbohydrate diet, n (%)	2 (8)	1 (5)	1.00
Mediterranean diet, n (%)	3 (12)	1 (5)	.62
Weight			
Weight (*kg*)	112.6 ± 4.9	114.3 ± 4.6	.80
BMI (kg/m^2)	39.3 ± 1.3	37.3 ± 1.4	.31
Abdominal circumference (*cm*)	120.5 ± 3.8	120.0 ± 2.8	.92
Lipid profile			
Low-density lipoprotein (*mg/dL*)	96.3 ± 4.9	105.9 ± 7.1	.28
High-density lipoprotein (*mg/dL*)	46.1 ± 2.7	44.2 ± 1.7	.55
Triglycerides (*mg/dL*)	125.1 ± 11.9	166.0 ± 17.5	.06
Glucose homeostasis			
Fasting blood glucose (*mg/dL*)	101.8 ± 3.9	100.4 ± 3.7	.79
Hemoglobin A1c (%)	5.72 ± 0.18	5.78 ± 0.18	.80
Fasting serum insulin (*μIU/mL*)	15.9 ± 7.1	25.0 ± 2.3	.23
Blood pressure			
Systolic (*mm Hg*)	127.8 ± 2.6	130.0 ± 3.0	.59
Diastolic (*mm Hg*)	81.1 ± 1.9	83.0 ± 2.5	.56
Mean arterial pressure (*mm Hg*)	96.7 ± 1.8	98.6 ± 2.3	.51
Bioelectrical impedance			
Body fat (%)	41.4 ± 1.3	37.7 ± 2.0	.14
Lean mass (*kg*)	63.7 ± 3.2	70.5 ± 3.3	.15
Med Gem analysis			
Resting metabolic rate (*Cal*)	1927.7 ± 118.3	1975.0 ± 65.5	.73

NOTE. Unless otherwise indicated, numbers are mean ± SEM.

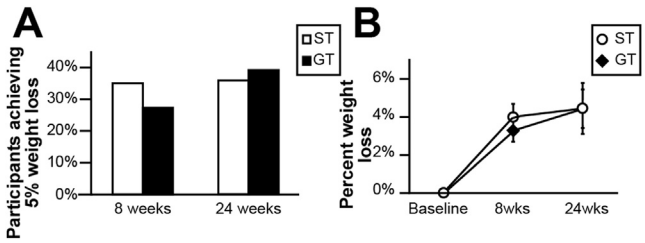

Figure 1. Weight loss in GT and ST groups. (*A*) Percentage of participants who achieved at least 5% weight loss. (*B*) Percentage weight lost by participants at 8 and 24 weeks.

the GT vs ST groups at 24 weeks (Supplementary Figure 3, Supplementary Figure 4, Table 2). Furthermore, no differences were found in measured parameters (Table 2).

Because the diets recommended by the genetic testing may be more difficult to maintain, the role of adherence was investigated in participants' weight loss. Adherence was measured through receipts returned for Healthy Choice meals in the first 8 weeks. The average returned receipt was 39 ± 4.1 (range, 0–110; note that maximum possible is 112). Participants were split into quartiles to analyze the results of effects of adherence. Across both groups there was a significant relationship between adherence and weight loss ($P = .001$). However, when the ST group was analyzed alone, no significant difference was found between the quartiles of the ST group ($P = .45$; Figure 2*A*). In the GT group, there was a significant relationship between adherence and weight loss ($P = .002$), and those in the top quartile of the GT groups had lost a significant amount of weight compared with those in the lower quartile ($P = .03$). There were no differences in weight loss within subgroups defined by adherence to the intervention between the ST and GT groups (eg, top quartile of adherence in GT versus top quartile of adherence in ST). The correlation between returned receipts and weight loss was quite strong across both groups ($r = 0.44$, respectively; $P = .001$; Figure 2*B*). However, when each group was analyzed separately, only the GT group had a significant correlation between adherence and weight loss at 24 weeks ($r = 0.74$, $P = 4.0 \times 10^{-5}$ for GT; $r = 0.34$, $P = .23$ for ST; Figure 2*B*, dotted line).

About one-third of the participants who were in the ST group would have been matched to the balanced diet on the basis of their genetic profile (Table 1). Hence, all the data were reanalyzed, grouping participants into those who were matched to their genetic-guided diet and those who were not matched. Again no significant differences were found between these 2 groups in weight loss, serum biomarkers, or anthropometric measures. In addition, there was no significant difference in adherence or weight loss by diet received (Supplementary Figure 5).

To find predictors of successful weight loss, a post hoc analysis was done to evaluate specific genetic profiles. Participants who were matched to the balanced diet on the basis of their nutrigenetic profile (balanced diet genotype [BDG], n = 14) regardless of which group they were randomized to (GT or ST) lost a significant amount of weight at 8 weeks when compared with other participants (5.0% ± 0.6% vs 2.9% ± 0.5%, $P = .02$; Figure 3*A*) and trended toward significance at 24 weeks (6.3% ± 0.9% vs 3.5% ± 1.0%, $P = .06$ at 24 weeks; Figure 3*A*). Furthermore, the BDG participants had a significant decrease in their BMI (6.4% ± 1.2% vs 3.6% ± 1.1% reduction, $P = .02$) (Figure 3*B*) and waist circumference (6.5% ± 0.6% vs 2.6% ± 0.1% reduction, $P = .03$) at 24 weeks (Figure 3*C*). Non-BDG participants who were consuming a balanced diet did not have as significant improvements as the BDG group did.

Because those with the BDG did particularly well in the MOVE! program, we measured whether nutrigenetic testing could play a role in prognosticating success (Supplementary Table 3). The sensitivity and specificity of nutrigenetic testing in detecting which patients would lose 3% of baseline weight at 24 weeks where the test performed best were 47% and 100%, respectively. The positive predictive value was 100%, and negative predictive value was 50%.

Discussion

The aim of this randomized controlled trial was to determine whether there was a difference in weight loss in a group who had the advantage of education on their genetically guided recommended diets compared with a group who were guided to follow a general balanced diet. GT and ST participants were not significantly different in any outcome measures, and as expected, diet adherence was a much more important factor in weight loss. Because this was a feasibility study, the sample size was small (n = 18 for the GT group and n = 14 for the ST group at 24 weeks). Analysis of the confidence intervals around the estimate of absolute benefit of GT at 24 weeks (which was 3.2% with confidence interval of −32.1% to 36.3%) is consistent with there being no difference at all or a difference of up to 30% in either direction. This suggests that the sample size of this feasibility trial is too small to exclude all clinically significant differences. However, on the basis of the observed 3.2% difference in this study, planning a sufficiently powered clinical trial would require 336 participants for each group (80% statistical power, α level of 0.05). This would involve either a considerable commitment of resources in a future study or methods that could enhance the efficacy of the current treatment. Furthermore, future research investigating nutrigenetic treatment effects on metabolic parameters might also consider using dietary intervention groups with larger macronutrient differences relative to the current study. In absence of new data, use of nutrigenetic-based diet management in usual practice is unlikely to be highly clinically effective.

On the basis of the correlative date, there is some suggestion that nutrigenetic-guided dietary recommendation

Table 2. Absolute Values and Percent Reduction in Patient Weight, Serum Biomarkers, Anthropomorphic Measures, and Resting Metabolic Rate

	Absolute values				Percent reduction			
	GT (8 wk)	ST (8 wk)	GT (24 wk)	ST (24 wk)	GT (8 wk)	ST (8 wk)	GT (24 wk)	ST (24 wk)
Weight								
Achieving 5% weight loss, n (%)	7/26 (27)	7/20 (35)	7/18 (39)	5/14 (36)	n/a		n/a	
Weight loss (*kg*)	3.7 ± 0.8	4.6 ± 0.8	5.0 ± 01.3	5.2 ± 1.5	3.2 ± 0.6	4.0 ± 0.7	4.3 ± 1.1	4.4 ± 1.3
BMI (kg/m^2)	38.2 ± 1.2	35.8 ± 1.4	38.0 ± 1.7	34.7 ± 1.9	2.6 ± 0.8	4.0 ± 0.7	4.4 ± 1.0	4.4 ± 1.3
Waist circumference (*cm*)	118.2 ± 3.6	116.7 ± 3.0	118.7 ± 4.9	114.6 ± 2.9	1.8 ± 0.7	2.8 ± 1.0	4.3 ± 1.0	3.2 ± 1.6
Lipid profile								
Low-density lipoprotein (*mg/dL*)	93.0 ± 5.9	88.7 ± 6.8	100.8 ± 8.2	113.6 ± 7.0	4.4 ± 4.4	16.3 ± 3.1	–5.3 ± 5.2	–5.6 ± 4.1
High-density lipoprotein (*mg/dL*)	43.1 ± 2.6	44.6 ± 2.9	46.4 ± 3.5	49.1 ± 3.8	5.2 ± 2.9	4.1 ± 2.7	–2.7 ± 4.1	–3.1 ± 2.4
Triglycerides (*mg/dL*)	132.7 ± 11.7	147.1 ± 14.4	141.8 ± 13.8	144.6 ± 13.6	–14.4 ± 8.7	6.6 ± 6.3	–26.1 ± 13.6	4.4 ± 8.8
Glucose homeostasis								
Fasting serum glucose (*mg/dL*)	96.0 ± 2.3	96.0 ± 3.2	96.8 ± 3.8	93.0 ± 3.7	3.8 ± 2.4	3.8 ± 2.3	4.7 ± 3.0	2.9 ± 4.0
Fasting serum insulin (*μIU/mL*)	21.3 ± 4.4	15.9 ± 2.3	18.7 ± 3.7	13.4 ± 1.7	–12.7 ± 10.0	1.8 ± 11.0	12.0 ± 10.2	7.5 ± 15.2
Hemoglobin A1c (%)	5.37 ± 0.10	5.58 ± 0.13	5.54 ± 0.15	5.54 ± 0.11	4.0 ± 1.7	3.1 ± 1.3	0.6 ± 1.7	0.7 ± 1.3
Blood pressure								
Systolic (*mm Hg*)	124.1 ± 2.0	124.4 ± 2.3	127.4 ± 3.1	124.6 ± 2.7	1.9 ± 1.7	4.0 ± 2.2	1.4 ± 2.5	3.9 ± 2.7
Diastolic (*mm Hg*)	80.1 ± 1.8	79.4 ± 1.7	81.0 ± 2.6	81.2 ± 21.6	1.0 ± 2.0	3.6 ± 2.2	0.5 ± 2.6	4.7 ± 2.0
Mean arterial pressure (*mm Hg*)	94.8 ± 1.7	94.4 ± 1.7	96.5 ± 2.4	95.7 ± 1.7	1.3 ± 1.7	4.0 ± 2.0	0.7 ± 2.3	2.2 ± 2.0
Bioelectrical impedance								
Body fat (%)	41.9 ± 2.2	35.8 ± 1.2	39.7 ± 1.9	36.6 ± 2.6	2.0 ± 1.1	4.3 ± 1.9	4.1 ± 1.6	7.2 ± 2.3
Lean mass (*kg*)	61.3 ± 3.0	69.4 ± 3.2	61.4 ± 3.5	66.4 ± 2.6	2.0 ± 0.8	1.3 ± 1.3	1.9 ± 1.5	–0.5 ± 1.8
MedGem Analysis								
Resting metabolic rate (*Cal*)	1905.8 ± 113.2	1865.3 ± 77.3	2020.9 ± 123.5	1942.9 ± 60.5	0.1 ± 3.1	4.2 ± 3.0	–5.7 ± 4.0	–2.8 ± 2.8

n/a, not applicable.

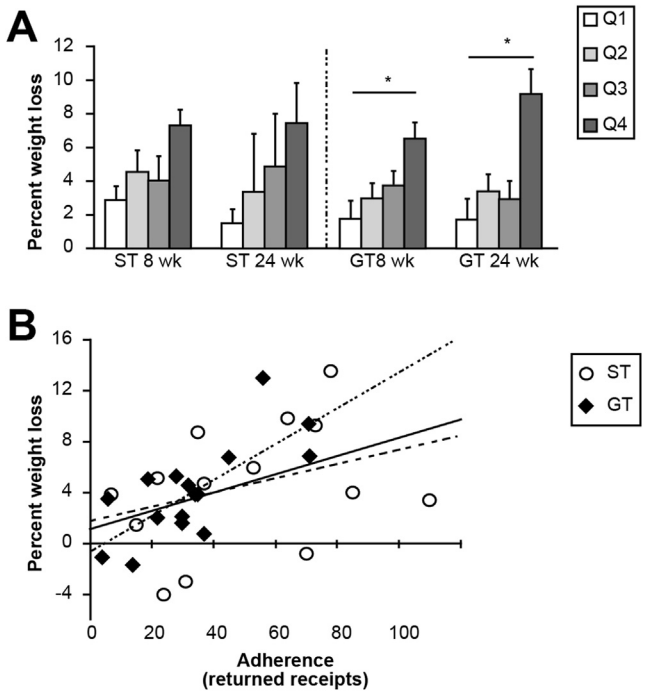

Figure 2. Adherence and weight loss. (*A*) Adherence was measured by amount of receipts of Healthy Choice meals returned for reimbursement during first 8 weeks. Those in the top quartile of GT participants lost significantly more weight than those in bottom 2 quartiles, whereas this was not true for ST group (*$P < .05$). (*B*) Correlation plot showing relationship between returned receipts (measure of adherence) and percent weight loss. *Solid line* shows trend line for all participants ($R = 0.47$, $P = .001$). *Dotted line* shows trend line for GT participants ($R = 0.74$, $P = 4.0 \times 10^{-5}$), and *dashed line* shows trend line for ST participants ($R = 0.34$, $P = .23$).

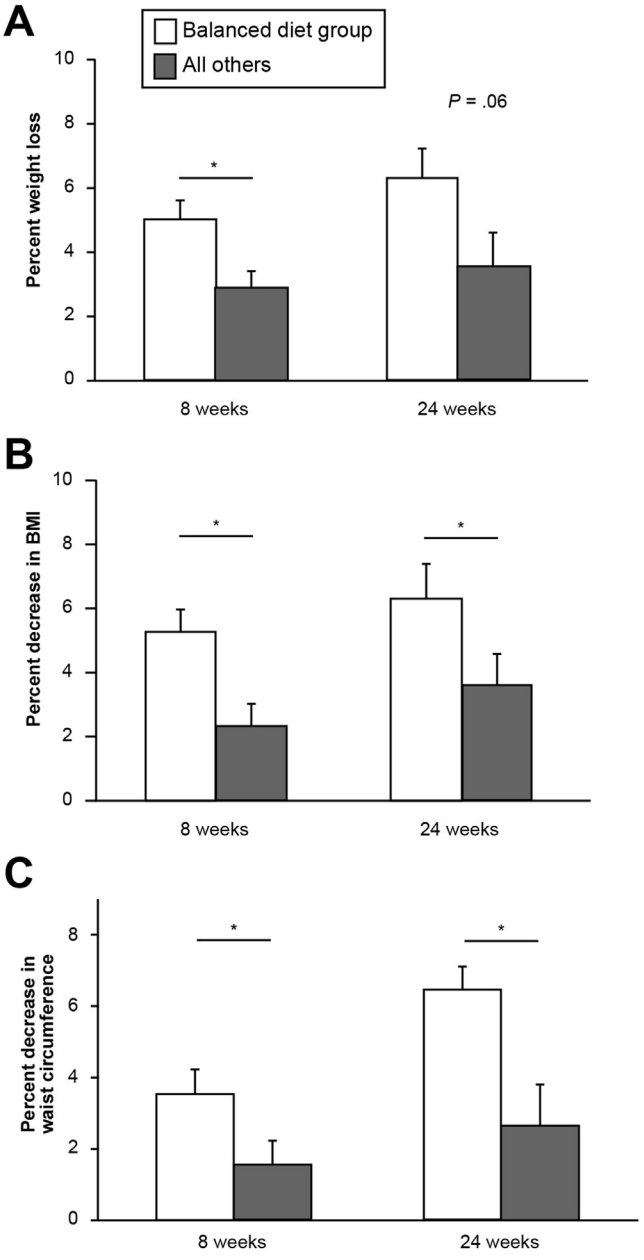

Figure 3. BDG performed better with lifestyle modification. (*A*) Percentage weight lost by BDG participants (versus all others) at 8 and 24 weeks ($P = .02$ and $P = .06$, respectively). (*B*) Percentage change in BMI by BDG participants (versus all others) at 8 and 24 weeks ($P = .02$ and $P = .03$, respectively). (*C*) Percentage decrease in waist circumference of BDG participants (versus all others) at 8 and 24 weeks ($P = .01$ and $P = .02$).

may offer a benefit to those who are most adherent to their recommended diet plan. The relationship between diet adherence and weight loss was very strong in participants in the GT group. Adherence was also important for the ST group, but our study may have had a sample size too small to have sufficient power to detect a correlation.

Nevertheless, the problem with nutrigenetic-based personalized diet therapy is that recommendations to alter dietary intake remain a poor treatment for obesity because of non-adherence. Even when given their nutrigenetic information with guided education regarding their nutrigenetic-based diet, GT participants were no more adherent to their diet than those in the ST group. In the post hoc analysis, there is some suggestion that nutrigenetics might be used as a potential predictor of individuals who would benefit from lifestyle modification and dietary intervention. In the BDG group, 100% of participants were able to lose at least 3% of their body weight, whereas only 50% of participants who were genotyped to other diets lost that amount of weight. These absolute differences in weight are likely clinically significant because even minimal to moderate weight loss has been found to confer health advantages.[32] Hence, the role of nutrigenetics in personalized therapy against obesity may be to give clinicians an idea of whether the participant will be successful with lifestyle modification therapy or whether a more aggressive therapy is needed at an early stage.

The value of the use of nutrigenetic testing to predict who will be poor responders to lifestyle modification could be clinically significant in the treatment of obesity. Clinicians may be able to shift the focus of intervention as the preferred treatment modality to earlier medication use or bariatric surgery in those predicted to be

poor responders. This could potentially provide results more quickly, shortening the period of time that the patient will have obesity or its associated metabolic disorders and with less distress to those who would first need to fail dietary intervention before advancing to other treatment options. However, not only does nutrigenetics have to be a good predictor of who will fail lifestyle modification, but also there needs to be an alternative, more aggressive therapy from which those who are predicted to be poor responders will gain a therapeutic benefit. Whether the most effective aggressive therapy is meal replacement, pharmacotherapy, or bariatric surgery will need to be stipulated in future studies.

The use of the Veterans Administration population participating in the standardized weight loss program MOVE! provided a great enrollment pool, but this group is very different from the general population.[33] In a study of the MOVE! program's effectiveness for providing weight loss, less than 1 in 5 veterans lose 5% or more of their body weight, with only an average of 3.6-pound weight loss at 6 months.[31] It is notable that participants lost more weight at 6 months and a greater percentage achieved 5% weight loss in both groups compared with the standard MOVE! results, likely from more aggressive follow-up and meal replacement in the initial 8 weeks.

With the rising interest in personalized medicine from both providers and participants and the increasing inclination of physicians to use genetic-guided therapies,[34] nutrigenetics will remain a growing factor in those treating obesity and its related disease. However, many problems still remain. There is yet no consistency in nutrigenetic reports from various companies, and costs remain high.[11] This study shows that personalized nutrigenetic recommendations for diet are still premature and cost-ineffective. Although the expectation remains that the costs of nutrigenetic testing will continue to fall with advances in sequencing technology,[12] the lack of effective remedies for obesity remains the main hurdle for nutrigenetic-guided personalized therapy.

Supplementary Materials

Note: To access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org, and at http://dx.doi.org/10.1016/j.cgh.2015.02.044.

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Conflicts of interest
These authors disclose the following: This was an investigator-initiated study funded by an industry sponsor, Pathway Genomics Corporation. M.L.K. has worked as a contract dietician for Pathway Genomics, the study sponsor, for work distinct from this study. K.L.H. is non-compensated member of the scientific advisory board for Pathway Genomics. The remaining authors disclose no conflicts. The funders had no role in design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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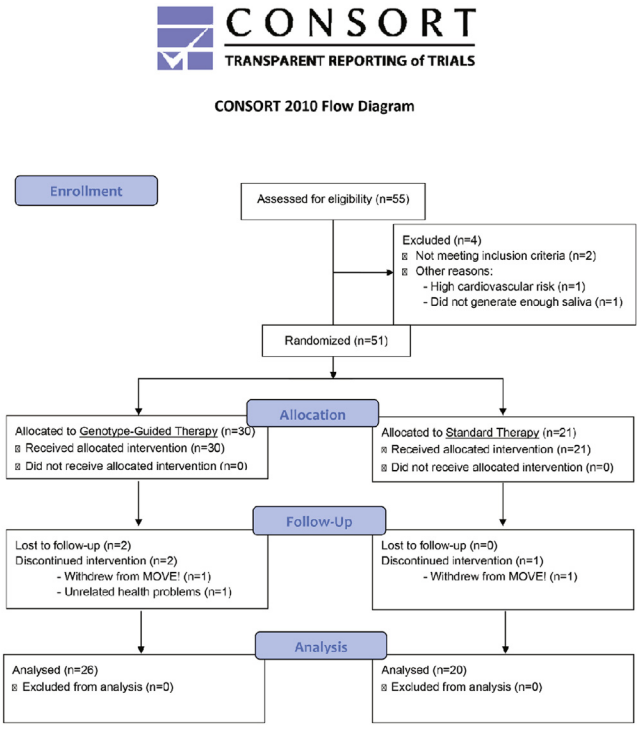

Supplementary Figure 2. CONSORT diagram.