Consensus paper

Weight management with a gene-based diet
Abstract
The prevalence of increased weight is rising globally, related both to dietary factors and to a sedentary lifestyle. It heavily contributes to the explosive development of e.g. type-2-diabetes or cardiovascular disease (CVD). Simultaneously, it reduces productivity at work and consumes huge amounts of medical care resources. These facts have focused attention on the determinants of this development. But not everyone is gaining weight when exposed to the same living conditions.

So it may be assumed that genetics play an important role in the interaction between nutrition, lifestyle and body weight. An individual, tailored weight management program which combines genetic testing with subsequent directions to nutrition and exercise could lead to effective weight reduction and lifelong.

Introduction
The main public and clinical health challenge of the 21st century seems to be increased body weight. A sedentary lifestyle and easy access to palatable food cause in a lot of people an excess of fat or adipose tissue.

However, medical state of knowledge definitely requires a lifestyle with regular exercise, behavioral therapy1 and a well-balanced diet to lessen the risk of multitude diseases and to stay healthy in old age. Simultaneously aesthetic reasons and the perception of “slim” as a desirable life concept in industrial societies cause numerous overweight individuals to think earnestly about losing weight.

In contrast to the multitudinous diets and weight control programs offered on the market, a combination of a weight management program with a genetic test may be able to incorporate the observation that not everyone is gaining weight despite the fact that we are all exposed to the same environment and may follow a very similar lifestyle.

The objective of this paper is to emphasize the benefits of an individual, tailored weight management program on health. The holistic approach of a gene-based diet program can fit the single person and this person’s needs. So the individual will be probably more successful in losing weight.

Background
To date there have been several international surveys, such as the WHO Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases (MONICA) and the WHO Countrywide Integrated Non-communicable Diseases Intervention (CINDI). According to reports of the International Obesity Taskforce, there are about 1.1 billion overweight and 350 million obese people worldwide2 (overweight refers to a BMI of 25 to 29.9, obesity, a BMI of 30 or higher). Further increasing rates are predicted for the next decade. In the U.S. already two-third of the adult population is either overweight or obese3.

There have also been several studies on the prevalence of overweight and obesity in Europe, most of which have involved national or regional cross-sectional surveys. Based on the latest WHO estimates in European Union countries, overweight affects 30-70% and obesity affects 10-30% of adults in European countries4. In Turkey, the prevalence of obesity is one of the highest in Europe. In a study covering all 7 geographical regions (Aegean, Black Sea, Central Anatolia, Eastern Anatolia, Marmara, Mediterranean and Southeast Anatolia) of Turkey 56% of the 4,205 included persons aged from 20 to 85 years were overweight5.

A cross-sectional nationwide survey on 2,100 adults aged 18 to 65 years showed that obesity in Turkey was more pronounced among females (34.19%) than among males (20%)6. Logistic regression analysis revealed
that older age and education level among females, and older age and occupational status among males have impact on obesity. Looking east, Ukraine ranks among Europe’s leading countries according to the number of overweight people. According to the WHO, 53.5% of the population is overweight and 21.3% suffer from obesity.

In Germany, about every second woman and two out of three men are overweight or obese. Italy can be regarded as an outstanding exception among the European countries. A very recent review considering the data of 5 surveys conducted annually between 2006 and 2010 did not find unfavorable trends in overweight and obesity prevalence over the last years. Overall, 31.8% of the Italian population was overweight, and 8.9% obese. However, there were specific subgroups of the population with elevated prevalence of overweight and obesity, mainly adults from southern Italy and less educated ones.

Even in a small country as Austria, significant regional differences with respect to overweight and obesity can be found with the highest prevalence in the eastern part. An Austrian-wide study showed that in young males the prevalence of overweight and obesity doubled between 1986 and 2005. Actually, one in seven EU children is overweight or obese and more than half of adults in European Union also. These figures are set to rise even further. The recent increase in the worldwide prevalence of obesity has understandably focused attention on the environmental determinants of this epidemic.

Epidemic degrees: increased body weight during the next decades

Only 60 years ago, after the end of the Second World War, the phenomenon affected only a minority in European industrial nations. In Third World Countries, government and health care organizations are still fighting malnutrition to date. But in European industrial nations the situation has changed dramatically, especially during the last two decades. The transition is mostly due to different eating habits and lifestyle: sedentary living plus the intake of food rich in calories and triglycerides result in an excess of body mass and expose individuals to a higher risk of certain (chronic) diseases and medical disorders.

Disease rates increase as well

Just as the rate of increased body weight, the rates of e.g. type-2-diabetes mellitus, hypertension, joint deterioration or CVD are rising alarmingly in industrial and also in emerging nations. The definition of the International Diabetes Federation for the so-called “metabolic syndrome”, a combination of medical disorders and a high-risk factor for carriers for a band of chronic diseases, includes apart from medical characteristics for type-2-diabetes mellitus only typical features of overweight: increased level of blood triglycerides, microalbuminuria or hypertension.

Which diet is the answer?

Multiple reasons will trigger an organism to excessively gain weight: environmental factors and behavior as well as hereditary and genetic criterions. Efforts to lose weight correspond to the high rates of overweight: for different reasons, most overweight people are highly motivated to lose weight but find it difficult to do so, and if they succeed, even more difficult to maintain weight loss. So over 45 million Americans start some sort of weight losing program each year – with little success. Only about half the people enrolled actually lose weight and the rest lose very little or actually gain some weight. In addition, it is widely reported that most people regain the weight within five years, the so-called “yo-yo-effect” or “yo-yo-dieting”. As there is a broad range of factors that can impact on weight management, holistic approaches have
been developed addressing the underlying metabolic and psychological factors of overweight and obesity.

There are many types of holistic diets, but most focus on eating whole foods that are low in fat, cholesterol and refined sugar, and are free of chemicals and preservatives – eventually coming back to low calorie intake.

As overweight is the result of a long-term positive energy balance, calorie restriction is crucial for losing weight. In a systematic review a mean weight loss of 5 to 8.5 kg (5% to 9%) was observed during the first 6 months from interventions involving a reduced-energy diet. In studies extending to 48 months, a mean 3 to 6 kg (3% to 6%) of weight loss was maintained with none of the groups experiencing weight regain to baseline. In contrast, advice-only and exercise-alone groups experienced minimal weight loss at any time point26.

“One size does not fit all”

Though weight gain and loss can be considered as a function of calories, its magnitude seems to be genetically determined. This led to the idea that a successful diet should be individual tailored to an individual's genetic make-up or genotype. According to the particular pattern of genetic variation, personalized advice can be generated that contains recommendations on dietary and lifestyle modifications to attain genetically based, specific goals in nutrition and exercise. In a clinical study “nutrigenetically” tailored diets resulted in better long-term BMI reduction and improvements in blood fasting glucose27.

**Dietary and genetic evolution**

The approach of individual tailored diets is supported by the fact that not everyone exposed to the current lifestyle and an obesogenic environment becomes overweight. So the development of overweight seems not to be only a lack of self-control. It may be assumed, that genetics play a major role in determining the individual susceptibility to increased body weight when exposed to a tempting environment. Only recently have we begun to develop a genuine understanding of the critical role of specific molecules in sensing the state of nutrient storage and regulating food intake and energy expenditure28,29.

Reports from the Stone Age (35.000-10.000 BC) suggest a low intake of triglycerides (<22 as en%) and a high protein and carbohydrate consumption (about 40 as en%). The vagrant lifestyle on a diet low on triglycerides lasts for the subsequent 10.000 years, and markedly affected the macronutrient intake (protein 19-35 as en%, carbohydrate 22-40 as en%, triglycerides 28-58 as en%).

With advances in agriculture, livestock breeding and the shift to permanent settling done (10.000 BC to third millennium), the achieved values during the last century were 10-17 as en% for protein, 40-60 as en% for carbohydrate and 20-59 as en% for triglycerides, a lesser intake of protein but more carbohydrates and still more triglycerides. In most industrial nations actually still a huge amount of fatty acids (40-50% E), especially saturated ones, is consumed, in spite of the sedentary lifestyle. The intake of carbohydrates generally subsided (40-45%)30.

In contrary, since the time when modern mankind appeared (about 150.000 years ago), only minor changes have occurred in the human genome. Only a difference of about 1.6 % in the gene setting between modern man and most developed primates has been found. In spite of this overall stability of the human genome, a number of minor alterations in gene structures have been observed. Genome sequences between humans differ in single base exchanges, called Single Nucleotid Polymorphisms (SNP). There are several millions of these SNPs, which are distributed throughout the genome. Thus
ethnic and racial differences for various traits have long been recognized. While the rising prevalence of increased body weight is related to increasing ease of access to high-energy palatable food combined with diminishing requirement for physical activity, differences in inter-individual susceptibility to obesity are likely to be related to inherited variation in the efficiency of central control mechanisms influencing eating behavior. Importantly, for overweight individuals numerous SNP’s have been discovered and characterized during the last two decades. These genetic variations can heavily impact the body’s reaction to lifestyle and nutrition.

The role of genetics in developing overweight

The complex phenomenon of increased body mass rarely arises from a unique mutation in a single gene. Knowing about the genetic predisposition may increase the likelihood of being successful in a weight management program. During the last two decades an understanding of pathways that control body mass and fat deposition in humans as well as the idea to provide personalized treatments and prevention strategies to fight against overweight constantly has grown in the scientific community. To date a large number of candidate genes are found to be associated with overweight-related traits. This illustrates the today’s state of scientific knowledge: overweight is not originated by one gene, but depends of various factors such as several gene variations and their interactions with lifestyle factors, such as dietary pattern and physical activity.

Which SNPs are appropriate and why?

Screening the evidence of all genetic variations that were associated with body weight, body mass index or body fat, using the Obesity Gene Map review, those were identified that had been replicated in at least three clinical studies. Only 16 genes came up to all expectations. Another set of scientific criteria ought to tailor further the selection. Five variations in a total of four genes met all of the required issues and were included in the specific genetic test for a new weight control program.

- Fatty acid binding protein 2 (FABP2) Ala54Thr
- Peroxisome proliferator-activated receptor-gamma (PPARG or γ) Pro12Ala
- Beta-2 adrenergic receptor (ADRB2) Arg16Gly
- Beta-2 adrenergic receptor (ADRB2) Gln27Glu
- Beta-3 adrenergic receptor (ADRB3) Arg64Trp

All genes or variations impact various pathways that influence body weight and have been associated with elevated risk for overweight and for their ability to differentiate the unique response to weight management interventions by genotypes.

Fatty acid binding protein 2 (FABP2) Ala54Thr

The Fatty acid binding protein 2-gene expresses the intestinal form of Fatty acid binding protein 2 (FABP2). Affecting the absorption of fat in small intestine, polymorphisms or variations in DNA result in a higher binding rate of fatty acids from the food bolus, a higher absorption of triglycerides and a long-term positive energy balance.

The polymorphism Ala54Thr has been associated with elevated BMI and body fat, increased abdominal fat, obesity and higher leptin levels. Carriers of two copies of the 54Thr/Thr variant show increased levels of postprandial triglycerides and increased levels of 14-18-carbon fatty acids. Subjects...
were selected from participants from a weight reducing program and from the non-diabetic control group of another study at the University of Kuipo, Finland. Compared to the wild type 54Ala/Ala individuals with the Thr54 allele failed to have a significant reduction in fat tissue, LDL-cholesterol and leptin levels, after exposure to a 3-month lifestyle modification program with regular aerobic exercise and a hypocaloric diet (about 1.500 kcal/d). It can be assumed that the Ala54Thr polymorphism of FABP2 specifically influences small intestinal lipid absorption.

Peroxisome proliferator-activated receptor-gamma (PPARG-γ) Pro12Ala
Second in line, the Peroxisome proliferator-activated receptor-gamma (PPARG-γ) is a transcription factor that has a pivotal role in the differentiation of fat cells and expression of adipocyte-specific genes. The protein is a component of adipocytes. The incidence of the Ala12 allele results in a reduction in the transcriptional activity of PPARG-γ and was associated with an increase of insulin sensitivity. Conditions like hyperinsulinemia or hyperphagia (excessive intake of food) can be a result. They are associated with glucose intolerance, obesity, hypertension and dyslipidemia, collectively known as metabolic syndrome. Clinical studies compared carriers of the 12Pro/Pro genotype with the Ala12 type. The former were more affected by the amount of fat in the diet and had a direct association between higher BMI and the amount of fat intake as opposed to the Ala12 individuals. They have also a higher risk of becoming overweight when eating a carbohydrate rich diet. These findings suggest that the PPARGamma2 Pro12Ala variant may contribute to the observed variability in BMI and insulin sensitivity in the general population. It may be assumed that a dietary conclusion such as an high protein intake may be beneficial.

Initially middle age subjects were studied in the Finnish branch (n=257), subsequently results were confirmed in elderly participants (n= 695). The clinical use of PPARgamma agonists results in body weight gain, which fits with the lower activity of the carriers of the mutant.

Beta-2 adrenergic receptor (ADRB2) Arg16Gly and Gln27Glu
The beta-2 adrenergic receptor (ADRB2) gene product ADRB2 protein is also a component of adipocytes. It affects the hormone-driven mobilization of triglycerides in this cell type for energy, sensitive to the changing level of catecholamines. Polymorphisms of the gene result in amino acid changes in the protein.

Two variants, the Arg16Gly and the Gln27Glu allele, are a matter of scientific interest, because they are the most common in Caucasians and possess the most positive associations of all variations of the ADRB2 locus with overweight. A couple of clinical studies supplied evidence, that especially the ADRB3 polymorphism is associated with greater weight gain over time. All studies involved exercise and/or endurance training.

Associated data suggest also a connection between the Gln27Glu allele and a higher risk to develop increased body weight, especially in the abdominal region. The study population showed excessive weight gain, when exposed to long-time overfeeding on a high carbohydrate diet and also experienced a greater increase in insulin resistance. The study was conducted with identical twins, young adults (age 21± 2y) and mean body mass index (BMI) (19.7±2.0 kg/m²). Because of these findings it could be assumed that genetic variation at the ADRB2 locus are one of the factors responsible for the large
inter-individual differences observed in the response to long-term alterations in energy balance.

**Beta-3 adrenergic receptor (ADRB3) Arg64Trp**

Lipolysis, the breakdown of fat in adipocytes for energy, plays a key role in losing weight. The activity is strongly connected with the regulation of blood glucose levels. The beta-3 adrenergic receptor (ADRB3) protein is expressed in visceral adipose tissue and the fat depot and regulates among others this process. A common polymorphism in this gene, characterized by an amino acid replacement of tryptophan by arginine at position 64 (Arg64Trp), has been identified and may be linked to lower lipolytic activity accounting for lipid accumulation in adipose tissue. Arg64 carriers have a higher risk to develop overweight, but only in case of a sedentary lifestyle. In regard to BMI, multiple studies had shown a statistically significant association between BMI and the Trp64Arg polymorphism in a variety of populations. For example, the cited Meta-Analysis used data from more than 9,000 individuals, demonstrated a significant association of the Trp Arg polymorphism with BMI.

Last one of the five alleles chosen for the weight management program with a genetic test, the incidence of the Arg64Trp form seems to be strongly associated with difficulty in losing weight through diet alone. It could be assumed, that regular exercise plus a diet can trigger a loss in weight in carriers of this gene variation.

**The role of exercise can alter genetic disposition**

The incidence of both the ADRB 2 and 3 polymorphisms increases the risk of developing increased body weight, but this risk can be altered in both cases by different amounts of physical activity. So the addition of regular exercise to a weight control program based on genotypes seems to be mandatory to support diet recommendations and also to tailor individual requirements.

**Tailored dietary conclusions**

All five SNP results together are considered the genetic makeup. Taking into consideration metabolic consequences of these five gene variations, their frequency within human genes and their different effects for human metabolism, scientists have found a method to calculate from this individual genetic makeup. This genetic tracking has led to several reference groups with different diet recommendations. These may be:

- Responsiveness to fat restriction or low fat diet
- Responsiveness to carbohydrate restriction or low carb diet
- Responsiveness to a balance of fat and carbohydrates

Individuals who respond to a low fat diet tend to have a slower metabolism compared to standard population. They easily gain weight, because they absorb more fat from the food intake. It can be reasonably assumed that these subjects have an easier time reaching a healthy body weight by decreasing total dietary fat intake. In addition they may benefit more than non-carriers from replacing saturated fatty acids with mono- and polyunsaturated fatty acids within the calorie restricted diet. Moreover, it is possible that such modifications can improve the body’s ability to metabolize carbohydrates and triglycerides.

Responders to carbohydrate restriction diet have a higher risk to gain weight from excessive carbohydrate (especially sugar) intake. Besides from having a greater success on a weight management program by reducing carbohydrates within a calorie-restricted diet, their blood glucose levels could be optimized as a side effect. Especially the risk of developing Type-2-diabetes mellitus could be reduced.
Replacing simultaneously saturated fatty acids with mono- and polyunsaturated ones could lead to an additional benefit. Well-balanced macronutrients seem to be the right way to lose weight for the third group of subjects. They show neither need for low fat nor low carb diet but balanced dietary advice.

The benefit of exercise
Some of the selected single nucleotide polymorphisms (SNPs) are responsive to physical exercise, especially the ADRB 2 and 3 polymorphisms. Therefore subjects with a responding genotype to exercise will already maintain weight loss with some kind of moderate exercise is included in the weight management program. These subjects may be recommended physical exercise at a moderate pace, 3 to 4 times a week. This is any activity on a “Metabolic Equivalent of Task (MET)” value from 3.0 to 5.9. An overall weekly MET-score of at least 7.5 METs should be achieved. This would be for example 3 hours slow walking per week. The type of sports should be appropriate for overweight individuals, like walking, swimming or moderate biking, especially at the beginning.

But individuals with a metabolic genotype that is less responsive to exercise are less able to break down body mass for energy when exercising than those with the alternative gene pattern. They need more exercise to stimulate lipolysis and lose weight. They should also maintain a consistent exercise schedule to keep the weight off.

These subscribers may be recommended high intensity physical exercise at any MET value of 6 or higher. This vigorous activity should be carried out at least 3 times per week. An overall weekly MET-score of at least 13 MET should be achieved. This would be for example 2 times 30 minutes running (8.5 km per hour) and 1 hour slow bicycling (15 km per hour).

Cave: the type of sports should be appropriate for overweight individuals, like walking, swimming or moderate biking, especially at the beginning. It is most important that the exercise is regularly carried out.

Discussion
The prevalence of overweight and obesity has increased sharply in the past 2 decades becoming a global health problem contributing to an increasing non-communicable disease burden. Long-term maintenance of weight loss requires permanent lifestyle changes in exercise and eating habits. Counselling and guidance improve success. However, the magnitude of weight loss seems to be genetically determined. In the past 20 years, studies with identical twins confirmed the importance of genetic differences regarding weight loss and weight gain.

There were substantial higher variances among pairs than within pairs51. In unselected populations dieting outcomes are highly variable even under research supervision52. In a clinical study after 6 months of supervised dieting only 50-55% of the study population had succeeded in loosing weight52. This led to the question if certain diets may be associated with a greater weight loss than others.

However, a clinical study comparing the efficacy of 4 different diets showed a broad range of weight loss indicating that the magnitude of weight loss may be genetically determined53. The Stanford A TO Z study demonstrated outcome variability similar to other reports when the patients were analysed regardless of genotype-patterns: on 4 different diets, only 14% lost at least 10 kg and 50-60% lost little weight (less than 2.7 kg) or even gained weight54. Altogether, these data showed that genetics play an important role in the interaction between nutrition and body weight. Extensive genetic research revealed that the risk for gaining bodyweight at least seems to depend on two important factors, which mutually interact: the genetic variants...
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and gene expression changes in candidate genes and the exposure to environmental factors. This led to the identification of several Single Nucleotid Polymorphisms (SNPs) correlating with body weight resp. weight loss. Recently, 3 clinical studies proved a considerably higher weight reduction on a genetically appropriate diet\(^5^4\).

The Stanford A TO Z study used 3 SNPs combined into genotype patterns based on evidence for diet interactions. The prospective study enrolled 311 overweight/obese (BMI 27-40) non-diabetic, premenopausal women who were randomised to 4 different kinds of weight-loss diets. Primary outcome was weight loss after 12 months\(^5^4\). Retrospectively, pre-defined genetic patterns were analysed. The results showed a clear genotype pattern interaction with diet that appeared to influence weight loss success on different diets. In this article, 5 SNPs located on 4 genes are described.

The SNPs were combined into 3 genotype patterns based on evidence for diet interactions. The genetic patterns proved to be strong predictors of weight loss, if the appropriate diet was used.

Though further clinically studies are needed to confirm the clinical relevance of the interaction of pre-defined genotype patterns with diet composition and exercise to improve weight loss, this data strongly suggest that genetically tailored diets may significantly contribute to solving the worldwide problem of overweight and obesity.

**Conclusions**

Overweight and obesity have become a global epidemic and an emerging health problem in Europe.

There is strong evidence that an individually tailored weight management program which combines genetic testing with subsequent directions to nutrition and exercise will lead to effective weight reduction.

Five Single Nucleotid Polymorphisms (SNP) located on 4 genes have been identified to crucially influence weight gain, these being fatty acid binding protein 2 (FABP2) Ala54Thr, peroxisome proliferator-activated receptor-gamma (PPARG or γ) Pro12Ala, beta-2 adrenergic receptor (ADRB2) Arg16Gly and Gln27Glu, beta-3 adrenergic receptor (ADRB3) Arg64Trp. The metabolic consequences of these 5 SNPs differ profoundly.

According to these differences, researchers identified 3 groups with different responsiveness to a certain type of diet: (1) Responsiveness to fat restriction or low fat diet, (2) responsiveness to carbohydrate restriction or low carb diet, and (3) responsiveness to a balance of fat and carbohydrates.

Regarding regular exercise, which is considered a cornerstone of weight management programs, the ADRB 2 and 3 polymorphisms were identified to be particularly responsive to physical exercise, meaning that subjects with these genotypes will already maintain weight loss with moderate exercise. Further studies will have to proof this individually tailored concept for weight reduction.

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He has authored and published over 180 articles in peer reviewed journals, such as Endocrinology, Diabetes, Diabetes Care, Lancet, Science, New England Journal of Medicine, Journal of Neuroscience, Journal of Clinical Investigation, Cancer Research and others. He has also written over 20 reviews and chapters of several Textbooks on Diabetes and Nutrition.

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References

1) Weblink: http://ajcn.nutrition.org/content/82/1/230S.full. Accessed at 06-2013,3th, 03:00 pm.
7) Gültekin T 2009, see above
8) http://www.who.int/mnh/countries/ukr_en.pdf

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52) LeCheminant et al. Comparison of a low carbohydrate and low fat diet for weight maintenance in overweight or obese adults enrolled in a clinical weight management program. Nutrition Journal 2007, 6:36


54) Gardner, JAMA 2007; 297: 969-97