Intestinal Flora and Obesity

1. Introduction

These cute mice have brought it to light:

Intestinal bacteria can be a culprit for being overweight.
In 2006, Jeffrey Gordon discovered and published the phenomenon that in mice, the microbiome can play an important role in the development of obesity. [1] [2]
Slim people differ from those overweight especially in the Bacteroidetes / Firmicutes ratio (BFR).
In some studies, in obese patients a lower proportion of Bacteroidetes and an increased proportion of Firmicutes could be detected, similar to the experiments with mice.
However, even under a low-calorie diet, the ratio of the two types could be normalized again.[2]

In slim and normal weight subjects, a higher proportion of Bifidobacteria and certain Lactobacillus strains could be detected. However, a high diversity of the intestinal flora is essential.
Amazingly certain Lactobacillus strains can even be associated with weight gain.[3]

Recent studies show that changes in the intestinal microbiota can also be linked to other lifestyle diseases such as lipid metabolism disorders (e.g. high cholesterol), insulin resistance and type 2 diabetes mellitus. [4] This symptom complex is summarized by the term metabolic syndrome, which is regarded today as a decisive risk factor for coronary heart disease and arteriosclerosis and its consequences. [5]
The findings of intestinal microbiota/microbiome research could be a new approach to treatment as well as prevention. [6]

2. Basics

2.1 Results of Studies

The majority of studies on humans come to the conclusion that the obese study participants, as in animal studies, show an altered ratio of the two bacterial types Bacteriodetes to Firmicutes (BFR) with an increased proportion of Firmicutes compared to slim test persons. [7]

Also, the stool samples of subjects with an increased Firmicute proportion contained about 150 Kcal less than the stool of those with a higher number of Bacteroides.
These calories are normally excreted with the indigestible bulking agents (fibre), but are apparently still absorbed due to the increased number of firmicutes and thus contribute to the calorie intake. [8]

[1] Gordon, J. 2006
[2] Ley, R.E. 2006
[3] Million M. et al., 2012
[4] Allin et al., 2015; Robles A. 2013
[5] Pies, Chr. 2010
[6] Baeckhead et al., 2004; Baeckhead 2011
[7] Ley RE et al; 2006
[8] Jumpertz R. et al ; 2011

This means that obese patients absorb about 10% more calories than lean participants in the same study using their microbiome. Thus, through the detour of the bacterial metabolism even dietary fibre, which is usually considered as slimming food, provides calories for them.
By transplanting an "obesity-promoting microbiome" both in rodents and humans, a significant weight gain and negative effects on sugar and fat metabolism could be achieved. [9]

2.2 Time related correlation of intestinal flora changes and resulting health consequences

Diseases such as diabetes mellitus type1, atopic diseases (e.g.eczema) or obesity are often preceded by changes of the microbiome by months or sometimes even years. [10] [11] [12] [13]
Several studies have shown that dysbiosis, for example caused by antibiotic therapy, increases the risk of obesity. Children who received an antibiotic in the first 6 months of their life were more often overweight at the age of 3 years than the control group. [14]
Even in adults, when the microbiome is already much more stable, antibacterial therapy leads to a disturbance of the intestinal flora, which seems to be a cause of being overweight or chronic inflammatory bowel disease. [15]
The risk of obesity and metabolic syndrome seems to increase when Bacteroidetes bacteria are under-represented, and at the same time a low microbe-diversity appears to increase the risk. [16]
For this reason, the intestinal flora analysis could become an instrument of prevention.

2.3 Causes of a modified intestinal flora composition
Various factors can upset the intestinal flora. These include, as already mentioned, antibiotic therapies. However, these often important antibiotic therapies need to be followed up with testing and analysis. Our normal gut flora also has to be nourished accordingly. For example, chlorine in drinking water, a low-fibre diet that is too rich in fats, processed carbohydrates and sugars, etc. disturb the balance.
Long-term stress and lack of sleep alter the composition and stability of the intestinal flora as well.

2.4 Consequences of a modified intestinal flora composition
Almost everything that disturbs the balance of our intestinal bacteria can also lead to an increased permeability of the intestinal walls, the leaky gut syndrome.
This permeability leads to overreactions of our immune system, and the defence cells trigger inflammatory reactions. Even the development of inflammatory bowel disease is associated with the leaky gut syndrome.
This inflammation increases the permeability of the intestine - a vicious circle - and it promotes fat storage. The fatty tissue itself produces inflammatory mediators again.
For an intact intestinal barrier, a healthy intestinal flora is of great importance. In addition to many other tasks, the intestinal bacteria feed the intestinal cells and densify the protective mucus layer.
The nerve connection between the intestine and the brain even ensures that our gut bacteria influence our ability to learn and our motivation and emotions, e.g. 95% of the serotonin available to us is formed in the intestine. ("The gut–brain axis") It is also believed that disturbed communication between the brain and the digestive system due to dysbiosis is a cause of irritable bowel syndrome.

[9] Alang L et al. 2015
[10] Baeckhaed F. 2011
[11] Kostic AD et al. 2015
[12] Candela M et al. 2012
[13] Santacruz A et al. 2010
[14] Trasande L et al. 2013
[15] Thuny F et al. 2010
[16] Le Chatelier E et al. 2013

2.5 Weight loss through regulation of the intestinal flora
As already described under the heading " time related correlation ", intestinal flora changes occur often long in advance of the health problems.
It can also be assumed that in the opposite case, the composition of the microbiome must first change in order to achieve long-term beneficial effects on weight development and sugar metabolism. Possibly also these positive microbial changes will have to occur weeks or months in advance before changes in weight or sugar/fat metabolism can be detected.

3. Analysis of the specific intestinal flora

A stool test brings certainty.

Considering the fact that changes of the intestinal microbiota often precede changes in health problems for a long time, an analysis of the Bacteroides : Firmicute Ratio makes sense.
The Dr Hauss Laboratory in Kiel offers these tests:
- Obesity diagnostics: Bacteroides / Firmicutes ratio
- Leaky gut analysis: - Alpha-1- antitrypsin
  - Zonulin

4. Other factors that can lead to obesity and test options [5]

4.1 Diet
Of course, a sensible, wholesome diet is the basis of any weight and health management. Good explanations can be found in the listed literature.

4.2 Stress
Continuous stress can promote obesity, especially fat deposits in the abdominal area, the so-called “love handles”. Elevated cortisol levels are also associated with insulin resistance, which promotes the development of more obesity and the development of type 2 diabetes.
Constant stress initially causes an increase in cortisol levels, but over time it is not uncommon for adrenal exhaustion to occur, leading to long-term low cortisol levels.
At the same time, the anabolic hormones DHEA and testosterone will decrease with known consequences.
Cortisol and the other relevant hormones can be tested by using simple saliva tests, offered for example by the Dr. Hauss Laboratory.

4.3 Depression and obesity
In obesity, relatively low levels of tryptophan can be detected, the precursor amino acid from which the "happiness hormone" serotonin is synthesized. Those who are affected tend to compensate for this deficit by an increasing intake of carbohydrates and fats, leading to the metabolic vicious cycle of obesity and metabolic and endocrine changes.

4.4 Fatty tissue as an endocrine organ
Fatty tissue is metabolically active tissue. For example macrophages, nerve cells and others alongside blood vessels make up to 40% of all cells in adipose tissue. These are an important source of the pro-inflammatory cytokines (e.g., tumour necrosis factor-α and others) which can increasingly be detected in adipose tissue. This leads to a local and a systemic pro-inflammatory environment in the overweight.
Omega-3 fatty acids for example and various phytochemicals are regarded as a protection factor.

4.5 Specific Hormones

Leptin is sometimes called the satiety hormone. Alongside other functions it regulates the appetite and consequently our body weight. An increase in fat deposits is usually associated with increased leptin levels in the plasma, while a decrease in weight reduces this.
In obese patients, however, there is a so far inexplicable cellular, central resistance to the weight-reducing effect of this hormone.
When fat deposits are emptied, less leptin is produced, depending on the depletion state of the fat cells. The appetite rises and the yo-yo effect sets in. Sleep deficiency also lowers leptin levels, which increases the risk of nocturnal snacking.
Leptin can be detected with a blood test.

4.6 Involvement of the thyroid gland

The thyroid gland is one of the most important endocrine glands in our body and influences the metabolic activity. The iodine-containing thyroid hormones triiodothyronine (T3) and thyroxine (T4) influence heart, circulation and metabolism by increasing their metabolic rate.
Hypothyroidism results in slowing down all metabolic processes, so that in spite of moderate food intake weight gain and other typical symptoms can occur.
A blood test (TSH, free T3, free T4) provides information about the thyroid function.
Especially in cases of peri- or menopausal women this should always be remembered.

5. Strategies for maintaining a healthy intestinal flora to prevent obesity and other metabolic diseases

5.1 Strategy 1: Support for the correct Bacteroides / Firmicutes ratio

Diet and prebiotics

The "slim and beautiful bacteria" have to be promoted and the "love handle bacteria" should be expelled. This can be achieved by eating a strictly varied diet, which is poor in fast release carbohydrates (cakes, sugar, etc.) and saturated fats, but rich in fibre and protein. Two apples a day, eaten with the peel for example, promote the growth of "good" bacteria. Resistant starch can fulfil the same function. (Cooked, high-starch foods that form retrograded starch after cooling, such as boiled and then cooled potatoes, rice, or pasta - even when reheated.)
These nutrients act as prebiotics, "bacterial food or intestinal fertilizer".
There are also food supplements containing these prebiotics, e.g. inulin, oligofructose, lactulose, etc. Even coffee, enjoyed in moderation and without milk and sugar, or chicory coffee provide such useful bulking agents.
Another advantage of these so-called "intestinal fertilizers" is that they cause the release of satiating messengers, which in turn help in weight loss.

Probiotics

The correct composition of the intestinal flora can also be supported with probiotics. "Good bacteria" in our food can fulfil this function. Already in biblical times people have eaten fermented foods (sauerkraut, yoghurt, kefir etc) which when uncooked are rich in live lactic acid bacteria. However, these bacteria do not settle permanently in the intestine, however, they affect the resident flora very positively. To achieve the optimum effect, these "good" bacteria should be supplied regularly and in sufficiently high cell counts, and they should be able to survive the gastric acid barrier well enough. Bacteria like this are now well-researched and they are on sale as dietary supplements, e.g. as capsules.

To make sure that these useful helpers are also fed well, there are so-called synbiotics. These are preparations that combine probiotics and exactly the matching prebiotics. As a simple additive, e.g. for muesli or smoothies, they can be of practical help.
(E.g the German product Madena Darmkur)

Study results:
Studies have dealt with the question of which probiotic microbes the bacteroides strains are especially well supported.
Results, for example, were that *Lactobacillus gasseri SBT2055* was able to reduce visceral abdominal fat. [17]

The administration of *Lactobacillus rhamnosus* helped to speed up weight loss in a three month diet and even after the diet patients lost more weight. [18]
Taking *Lactobacillus paracasei* led to an increase in the saturation hormone glucagon-like peptide -1 (GLP-1). [18]

But !!! The increased administration of ***Lactobacillus acidophilus*** led to an increase in weight in humans and animals. ***Lactobacillus reuteri*** was also associated with overweight. This means that the strain specification is important.

Further studies have shown that prebiotics can also produce metabolic effects. Weight loss for example could be achieved by administration of fructo-oligosaccharides. [18]
Oligofructose was able to reduce weight and glucose and insulin levels and had good effects on satiety. (Eg inulin in Jerusalem artichoke, bananas, onions, garlic chicory root, leeks etc).
Resistant starch also affected calorie intake, body fat percentage, weight and insulin resistance. [19]
Pectin promotes the desirable bacteria and suppresses some unwanted ones. Pectin can be easily provided by for example the consumption of apples with peel. [20]

5.2 Strategy 2: Fiber is no useless ballast

Dietary fibres, although indigestible for us humans, are very useful as a bacterial food. But even those that are not metabolized by bacteria have important functions. They fill us up for longer, stimulate the intestinal peristalsis, cleanse the intestine, absorb toxins and can for example also absorb saturated fats.
You should eat at least 30g of fibre daily. However, if you have hardly eaten any fibre so far, the percentage in food should be increased slowly, to first allow the multiplication of the respective degrading bacteria. It is very important to add enough liquid to the fibre as it can absorb 4-5 times its weight in fluid. Without adequate drinking, it would form a "stopper", leading to constipation.

5.3 Strategy 3: Fortifying the gut barrier

An intact intestinal barrier determines what is allowed to enter the blood stream from the intestine and what is excreted. The balance of intestinal bacteria has a great importance for an intact intestinal wall as they provide nutrients for nourishing and regenerating intestinal cells. Thus, the leaky-gut syndrome can be prevented or even cured.
An important strategy to inhibit the inflammation that goes along with leaky gut is to consume lecithin (naturally occurring, for example, in soy products, walnuts,

[17] Kadooka Y et al. 2010
[18] Genta S et al 2009
[19] Guerin- Deremaux L et al 2013
[20] Shinoharaa K et al. 2010

buttermilk, eggs, peas and corn), certain spices, e.g. turmeric, black pepper, ginger, glutamin and unsaturated fatty acids.
On the other hand, too much fructose, which is found in processed foods and any household sugar, can damage the intestinal barrier, stimulate the build up of adipose tissue and even stimulate appetite. Adipose tissue, however, promotes inflammatory reactions which again cause overweight.

5.4 Strategy 4: Stimulate the satiety hormones

"Appetite is the little sister of hunger and the declared enemy of a slim waist."
Also our bacteria decide whether we will have a pleasant satiety feeling after a reasonable portion or if we want to continue eating.
A well-fed intestinal microbiome stimulates the hormone "peptide YY", which is formed in the intestinal cells and then transported to the brain. It releases a feeling of satiety and at the same time reduces the "starvation hormone" ghrelin. Ghrelin can be increased by stress and bad sleep. The same factors also increase the cortisol release, which increases abdominal fat.
With a balanced intestinal flora more satiety hormones are produced, e.g. Leptin and GLP-1.
GLP-1 also slows down inflammation, thereby affecting weight and health.
Protein-rich food attracts peptide YY, while fast-release carbohydrates even stimulate appetite. These rapidly degradable carbohydrates and sugars also cause insulin levels to rise rapidly, leading to a rapid drop in blood sugar levels shortly thereafter, which is why insulin is also called the craving hormone.

6. Bibliography

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(these are not indicated by numbers in the text):

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