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# Proceedings of the 2nd annual symposium of the German Society for Paleo Nutrition held in 2014

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# Proceedings of the 2nd annual symposium of the German Society for Paleo Nutrition held in 2014

**Abstract**

We present the scientific abstracts of the 2nd Annual Symposium of the German Society for Paleo Nutrition (*Deutsche Gesellschaft für Paläoernährung e.V.*) which was held on November 8th 2014 in Schweinfurt, Germany. The topics presented had a great variety that included (i) a discussion of specific foods (one talk addressed the potential problems associated with cow's milk consumption and one talk dealt with the staple foods of the Hadzda hunter-gatherers); (ii) the emerging role of ketogenic diets in the treatment of neurodegenerative diseases and cancer; (iii) an overview of intermittend fasting and its effects on health and performance; (iv) an extension of evolutionary principles beyond nutrition and their incorporation into everyday life in a way we term the *paleo concept*.

**Keywords**

Paleolithic diet, Paleo diet, Ketogenic diet, Nutrition, Milk

# ABSTRACTS

## The Ancestral scene in the Anthropocene: Why it is an important movement

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It is an emerging concept that, starting with the industrial revolution, human activity has driven global changes in the interlocking circuits of the Earth's atmosphere, hydrosphere, biosphere and crust, thereby altering the planet's geophysical and biological functioning and initiating a new geological epoch referred to as the Anthropocene [1]. As evidence is mounting that many of these changes may be too rapid to stay within safe planetary boundaries [2], the impact upon human health becomes a concern. Adding to this are the global changes in lifestyle patterns and natural resources that analogously may be too rapid to stay within safe boundaries of the human body. The controlling variables of human boundaries are manifold and may refer to, among others: (i) physical factors such as temperature, sunlight and artificial light exposure; (ii) psychosocial factors such as cognitive load, work stress and social bonds; (iii) biochemical factors such as the intake of micro- and macronutrients, phytochemicals, drugs and pesticides. From an evolutionary perspective the critical thresholds for most of these variables evolve too slow to keep up with the rapidly changing environment since they have been set during the millions of years of human evolution *before* we entered the Anthropocene and mostly even before we started to cultivate grains and switched from a hunter-gatherer lifestyle to sedentariness. In contrast, pathogens and cancers are characterized by rapid evolution and quickly develop resistances against cytotoxic treatments [3].

The good news is that evolutionary medicine provides us with several tactics to address the health problems arising from both the human phenotype-environment mismatch and contemporary evolution of pathogens and cancers [3]. The disastrous consequences of ignoring evolutionary principles when designing environmental manipulations in order to decrease the phenotype-environment mismatch cannot be better illustrated than by the dietary recommendations of the official food agencies that failed to prvent, and probably even contributed to, the rapid increases of noncommunicable diseases [4–6]. Therefore, approaches to re-naturalize the human environment based on a "paleo concept" are much more logical and promising (see abstract by Jörg Spitz below). Several such approaches have been a topic at the 2nd Annual Symposium of the German Society for Paleo Nutrition (*Deutsche*

*Gesellschaft für Paläoernährung e.V.*) which was held on November 8th 2014 in Schweinfurt, Germany, and is summarized in the abstracts of the scientific talks below. The Society has grown since its first symposium in 2013 [7], now comprising more than 160 members from Germany, Austria and Switzerland. As our Society grows in numbers, it also grows in expertise, and future topics will look beyond the nutritional environment to the full scope of Ancestral Health. Nevertheless, nutrition remains one of the key lifestyle factors that can be influenced by the individual. I therefore would like to thank the editors of the *Journal of Evolution and Health* for again providing an excellent forum for this abstract collection that hopefully inspires further thoughts on how nutrition and evolutionary biology can be combined to prevent and treat contemporary diseases.

## Back to the roots of Paleolithic nutrition - in the wild and in Western life

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About thirty years ago, Eaton and Konner called attention to Paleolithic nutrition as a way to promote health in modern life. They were one of the first to outline how a diet that takes the genetic heritage of human beings into account can help to prevent diseases of civilization like obesity, diabetes and some forms of cancer [8,9]
In recent years this kind of nutrition has attracted a significant public interest. Especially weight loss and enhanced physical fitness are well known and appreciated effects. However, a lot of different and partially contradicting views on what constitutes a 'Paleo diet' have emerged.

Science is the best way to separate facts from fiction. Therefore our idea of how the original Paleolithic nutrition looked like should be based on scientific data. There are five main research methods: (1) Archaeological records document what kind of animals and plants were eaten by hominins in a given geographic region and time. (2) Research on teeth and abrasion patterns reveals the type of food eaten. (3) Isotopic evidence demonstrates the relation of animal to plant sources of past diets as well as the type of animals eaten. (4) Genetic analyses determine since when metabolic activities were available or changed during human evolution. (5) Ethnographic studies provide knowledge about current hunter-gatherers, their diets and behavior.

One particularly interesting example are the Hadza, who still live as foragers at Lake Eyasi, Tanzania. They eat foods that are widely available in East Africa today and were present during human evolution. In this area the record of hominin fossils extends back to 3-4 million years ago. So the Hadza diet is


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a model for the Paleo diet [10]. During my stay with the Hadza people in 2013 I had the opportunity to get first-hand information on their hunting and gathering activities as well as their food. Here are some remarkable findings: 1) Hadza *hardly breakfast*. Usually they start hunting and gathering early in the morning without having a first meal. Two to three hours afterwards they eat part of their latest prey. Then they return to the camp sharing the rest with others. 2) *Eggs* are eaten seasonally and from a variety of birds. 3) One of the five major food categories are *nutlike baobab seeds*. They deliver a large amount of daily energy (19% of total energy; 388 kcal/100 g) and are available throughout most of the year [10 p. 115,11 p. 480]. 4) *Honey* is another main food, and is collected by men and women. 5) *Fat* is obtained from baobab and animals.

Based on these findings and recent scientific publications I suggest the following recommendations for a Western Paleo diet:
Breakfast is unusual for hunter-gatherers. After a first activity in the morning, however, a first meal is eaten. This is in line with the majority of people in Western countries who skip breakfast at least once or several times per week. They should have appropriate food with them for a Paleolithic snack about three to four hours after getting up.
Daily egg consumption from just one species (chicken) is not consistent with a Paleo diet. A greater variety can be achieved with eggs from duck, goose, quail, guinea fowl, amongst others, in the respective seasons. During the rest of the year and for preparing meals suitable egg alternatives are banana, pumpkin, flaxseed, carob, etc.
Seeds and nuts have been widely used in past and current hunter-gatherer diets. This is in line with beneficial effects of the so-called anti-nutrients which were discovered lately. Since seeds and nuts are valuable sources of fatty acids, minerals and vitamins, they contribute significantly to a Paleo diet.
Honey is an important part of the Paleolithic diet. Comb honey provides an authentic indulgence and additional nutritional value due to pollen and larvae.
Coconut oil, often used in Western Paleo diets, is not typical for African and European hunter-gatherers. Appropriate fat sources in addition to regional seeds and nuts are the almost forgotten lard and tallow, two excellent baking and frying fats.

Additionally, research on gastrointestinal microbes rendered interesting results. These microbes play a vital role in the uptake and metabolism of nutrients. An imbalance often leads to food intolerances and gastro-intestinal discomfort. Gut microbiota are the first line of defense against bacteria and viruses and influence the function of the immune system. In so far it is of special interest to learn more about microbiota of hunter-gatherers. A Hadza research project revealed that they have higher levels of microbial biodiversity and a different bacterial pattern than Italian urban controls [12]. Gastrointestinal microbiota can influence mood and eating behavior, some of them promoting obesity and

diabetes [13]. It is desirable to accommodate a microbiom contributing to positive mood and healthy eating behavior. Dietary changes can alter the gut microbiom within twenty-four hours [14]. Thus, by changing to a Paleolithic diet it should be possible to get positive effects within a short period of time.

A careful choice of suitable foods and eating habits will be a key to a successful implementation of the Paleo diet and optimal health effects in Western life. Further research in the lab and in the wild will provide a more comprehensive picture of the Paleolithic past - and might bear the one or other surprise. Our ancestors were successful as hunter-gatherers because they were curious and not afraid of unknown territories. So should we.

## Intermittierendes Fasten - Ein praxisnahes Konzept zur Verbesserung von Gesundheit und Leistung?

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Intermittierendes Fasten (IF) definiert sich durch einen (rhythmischen) Wechsel der Nahrungsabstinenz und der Nahrungsaufnahme. Fastenphasen von 16-36 Stunden sind hierbei der Regelfall. Ein derartiges Vorgehen führte in Tierstudien an Nagetieren in der Vergangenheit zu einer positiven Veränderung diverser Marker für kardiovaskuläre Risikofaktoren, Störungen im Glukosestoffwechsel, neurodegenerative Erkrankungen und Tumorwachstum. Intermittierende Fasten Phasen scheinen hierbei unter anderem die Effekte einer kalorienreduzierten Ernährungsweise nachzuahmen, ohne jedoch eine entsprechend starke Energiereduktion einleiten zu müssen.
Entsprechend wird dem IF auch beim Menschen großes Potential in der Vorbeugung und Behandlung diverser Krankheiten und für das Erreichen einer gesunden Körperzusammensetzung zugeschrieben. Die Studienergebnisse an Menschen lassen jedoch noch keine eindeutigen Schlüsse zu, wie und inwiefern IF alleine einen Einfluss auf die beobachteten Veränderungen hat. Humanstudien, welche häufig an aus religiösen Gründen fastenden Probanden durchgeführt wurden, legen zwar positive Effekte des IF im Bereich kardiovaskulärer Risikoparameter, der Körperzusammensetzung und der Entwicklung des Fettstoffwechsels, insbesondere bei während dem Fasten durchgeführtem aeroben Training, nahe. Allerdings sind diese Studien bisher meist von niedriger Qualität und beinhalten entsprechendes Konfliktpotential, weshalb die positive Bewertung des Fastens häufig primär von praktischen Erfahrungen geprägt ist und weiter diskutiert werden muss.
Praktische Erfahrungen lassen jedoch vermuten, dass das IF durchaus positive Effekte auf Probanden ausüben kann, insbesondere was die Compliance, eine energiereduzierte Ernährungsform beizubehalten, betrifft. Intermittierendes Fasten scheint daher eine gute Methode der Energiereduktion zu sein, sofern


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darauf geachtet wird, dass es zu keiner Mangelernährung in der Diätführung kommt.

## Milk as a promoter of diseases of civilization in Westernized countries

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Milk is considered an evolutionary developed, specific and complex nutrient in order to promote postnatal growth and species-specific metabolic programing for the early period of life. At a cellular level, growth and proliferation of cells, biogenesis of proteins and lipids, anabolic processes and inhibition of autophagy share many common molecular mechanisms, and in all of these processes the nutrient-sensitive kinase mechanistic target of rapamycin complex-1 (mTORC1) plays an essential role. Activation of mTORC1 is mediated by branched-chain amino acids, growth factors (e.g. insulin, insulin-like growth factor-1 (IGF-1)), AMP-activated kinase (AMPK)-mediated signaling and other factors. Milk, especially cow's milk and whey, is particularly enriched in branched-chain amino acids leucine, isoleucine and tryptophan. Leucine promotes the mTORC1-coupled signaling cascade (i) directly through Rheb (member of the Ras superfamily small GTPases), and (ii) indirectly, via induction of the secretion of insulin and incretins, such as glucose-dependent insulinotropic polypeptide (GIP) and/or intestinal glucagon-like peptide-1 (GLP-1). Tryptophan, derived from casein and alpha-lactalbumin, is able to increase the pituitary secretion of growth hormone (GH), which stimulates hepatic IGF-1 synthesis.
There is increasing evidence that chronic civilization disorders, such as obesity and type-2 diabetes ("diabesity"), Alzheimer's disease, acne and malignancies (particularly prostate and breast cancer), are associated with increased mTORC1 signaling. In this scenario, cow's milk is not only a simple nutrient for humans, but an extremely potent evolutionary program of the faster growing calf, leading to a sustained over-stimulated mTORC1 pathway in human consumers of cow's milk. It is tempting to speculate that "modified milk" with a reduced insulinemic index may prevent the over-stimulation of mTORC signaling, and thus lead to a reduced risk of civilization disorders.

# Ketogene Diät / Ketone als Therapieansatz bei Demenzerkrankungen: Hypothese und erste Berichte aus der Literatur

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Demenzielle Erkrankungen sind - nicht zuletzt aufgrund der demografischen Entwicklung – auf dem Vormarsch. Die hierdurch entstehenden und in Zukunft erwarteten Kosten und der Pflegeaufwand drohen die staatlichen Sozialsysteme ebenso wie die Familien zu überfordern. Besonders brisant ist die Situation angesichts des Fehlens heilender Medikamente: Bislang kann nur symptomatisch behandelt werden, mit zum Teil erheblichen Nebenwirkungen.

Vor diesem Hintergrund und angesichts der Tatsache, dass viele Risikofaktoren für eine (Alzheimer-)Demenz wie Insulinresistenz, Typ-2-Diabetes, Adipositas, Bluthochdruck und Schlaganfälle ernährungsmitbedingt bzw. durch Ernährung modifizierbar sind, kommt der Ernährung eine nicht zu unterschätzende Bedeutung in der Prävention und möglicherweise auch in der Behandlung demenzieller Erkrankungen wie Alzheimer zu [15].

Neben fettem Fisch (DHA, Protein, Jod), der erheblich zur Evolution des menschlichen Gehirns beigetragen und sich als präventiv erwiesen hat [15], spielt die Energieversorgung der Hirnzellen hierbei eine Hauptrolle. Denn eine der ersten Auffälligkeiten im Stoffwechsel der späteren Patienten ist eine verminderte Glukoseverwertung sowie Insulinresistenz in bestimmten, Alzheimer-typischen Hirnregionen, die die Energieversorgung insbesondere von Neuronen beeinträchtigen [16–18]. Sobald die Kompensationsmechanismen erschöpft sind, kommt es zu Funktionsausfällen und Zellniedergang. Hier können die in der Leber und in den Astrozyten aus Fettsäuren gebildeten Ketonkörper (Acetoacetat und ß-Hydroxybutyrat) Abhilfe schaffen: Sie können das bestehende Energiedefizit ausgleichen, da Neuronen auch Ketonkörper zur Energiegewinnung verwerten [19–21]. Darüber hinaus wirken die Ketonkörper neuroprotektiv, antioxidativ und antientzündlich und können so zum Schutz der Neuronen gegenüber endogenen und exogenen Stressoren beitragen [22,23].

In Zellkulturen und Tierversuchen konnten diese Effekte bereits mehrfach gezeigt werden [22,24]. Erste retrospektive [25] und Fall-Studien [26] sowie einige kleine Interventionsstudien [27–29] erbrachten auch beim Menschen vielversprechende Ergebnisse, wie messbare Verbesserungen in kognitiven Tests (z. B. im ADASCogScore), verbesserte sprachliche und Alltagsfähigkeiten, bessere Stimmung und Kommunikationsfähigkeit sowie Hirnscans, die zeigen, dass der Abbau von Hirnsubstanz zum Stillstand kam.


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Wenngleich es an großen klinischen Studien noch fehlt, ist hier eine echte Chance für die Patienten und ihre Angehörigen / Pflegenden erkennbar, zumindest, wenn rechtzeitig mit der Intervention begonnen wird. Zu den noch offenen Fragen gehören unter anderem:

- Bei wem und ab wann ist eine Versorgung des Gehirns mit Ketonkörpern sinnvoll bzw. notwendig?
- Wie hoch sollten die Ketonspiegel im Blut ausfallen und wie lassen sie sich langfristig stabil halten?
- Benötigen APOE4-positive Patienten höhere Ketonspiegel als Patienten mit anderen Formen des Transportproteins?
- Wie soll / kann die Ketonämie am besten bewerkstelligt werden?

Prinzipiell sind zum Erreichen einer Ketonämie (nicht zu verwechseln mit der unerwünschten Ketoazidose) derzeit drei, auch miteinander kombinierbare Wege möglich: (1) eine stark kohlenhydratlimitierte (< 50 g / Tag), fettreiche (= ketogene) Diät [22]; (2) die Gabe von mittelkettigen Triglyzeriden (MCTs) bzw. des von Natur aus MCT-reichen Kokosöls, die in der Leber bevorzugt in Ketone umgebaut werden [25,30]; (3) die direkte Gabe von Ketonestern [26].

## Metabolic Tumor Typing – Ernährung bei Tumorerkrankungen auf Basis unterschiedlicher Tumorstoffwechseltypen

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Der Energiestoffwechsel einer Tumorzellpopulation ist entscheidend für zahlreiche kritische Eigenschaften maligner Zellen. Zu diesen zählen unter anderem die Ausbildung von Resistenzmechanismen, immunologische Escape-Phänomene, die Fähigkeit zu Migration und invasivem Wachstum, Aufrechterhaltung hoher Mitoseraten sowie die Umgehung der Apoptose. Zwar gilt für die meisten Tumorentitäten die von Otto Warburg beschriebene erhöhte Laktatfreisetzung bei gleichzeitiger Suppression der mitochondrialen oxidativen Phosphorylierung. Allerdings lässt sich dieses Phänomen nicht alleine auf eine forcierte Vergärung von Glukose zurückführen. Tatsächlich verfügen maligne Zellen über ein erstaunlich breites Portfolio an Energiestoffwechselmodi und sind zudem in der Lage, ihren Metabolismus an veränderte Gegebenheiten und Anforderungen anzupassen. Die differenzierende Analyse des aktuell vorherrschenden Stoffwechselmodus (Metabolic Tumor Typing) ist für die Ausarbeitung eines individuell

stimmigen und effektiven Therapiekonzepts und die Staffelung der Interventionen ebenso entscheidend wie für die Evaluation eines adäquaten Ernährungskonzepts. Durch eine individuell optimierte Ernährung kann die Effektivität einer Tumortherapie signifikant erhöht und klassischen Komplikationen wie beispielsweise der Tumorkachexie entgegengewirkt werden.

Bei eingeschränkter Aktivität der Atmungskette kommt es grundsätzlich zu einer intermediären Akkumulation von Pyruvat, das entweder über eine forcierte Fettsäuresynthese entsorgt oder zu Laktat metabolisiert wird. Die erhöhte Laktatbildung lässt sich dabei mittels der Analyse der LDH-Isoenzyme (spezifische Erhöhung der Isotypen 4 und/oder 5) oder des Laktat-Pyruvat-Quotienten eruieren. Mit diesem Schritt kann der bekannte Warburg-Effekt diagnostisch gesichert werden. Allerdings lässt sich die erhöhte Laktatbildung nicht spezifisch auf eine forcierte Gärung zurückführen, sie belegt grundsätzlich nur eine eingeschränkte Aktivität der oxidativen Phosphorylierung. Alternativ stehen den betroffenen Zellen die Glykolyse, der Pentosephosphatweg sowie – eingeschränkt – die Glutaminolyse zur Verfügung. Da die Glutaminolyse über die Expression der M2PK (einer tumorspezifischen Variante der Pyruvatkinase) zu einer Rückwärtshemmung der Glykolyse führt, kann dieser Stoffwechselmodus über den Nachweis der M2PK (je nach Tumorlokalisation aus Plasma oder Stuhl) gesichert oder vorerst ausgeschlossen werden. Der Pentosephosphatshuttle korreliert sehr gut mit der Expression der TKTL1, die sich wiederum mittels des etablierten EDIM-Tests nachweisen lässt. Da die Glutaminolyse nur unter aeroben Bedingungen umsetzbar ist, erlauben diese einfachen Parameter im Zusammenhang mit Kenntnissen über Größe und Vaskularisation der jeweiligen Tumorentität Rückschlüsse auf den dominierenden Stoffwechseltyp innerhalb der Tumorzellpopulation. Die klinische Erfahrung zeigt dass in fast allen Fällen eine Mischung der Stoffwechseltypen vorliegt. Da ab einer bestimmten Tumormasse die anaerobe Energiegewinnung (und damit die Utilisation von Glukose) im Vordergrund steht, ergibt sich in der Gesamtbetrachtung eine klare Dominanz der zuckerabhängigen Stoffwechseltypen. Mit absteigender Häufigkeit finden sich **Penthosephosphatweg/**Glutaminolyse, **Pentosephosphatweg/**Glykolyse, **Glutaminolyse/**Glykolyse und zuletzt **Glutaminolyse/**Oxidative Phosphorylierung. Somit lassen sich zumindest bezüglich der Ernährungsweise eindeutige Empfehlungen ableiten. Da in über 80% der Fälle der Zuckerstoffwechsel dominiert und dieser in über 95% der Fälle zumindest vertreten ist stellt ein minimaler Kohlenhydratumsatz generell eine wünschenswerte Ausgangslage dar. Gleichzeitig werden Fette in weniger als 5% der Fälle utilisiert, Ketone quasi gar nicht. Somit ist die ketogene Ernährung in fast allen Fällen das schlüssigste und effektivste Ernährungskonzept. Integriert man zusätzlich einen minimalen Glutaminumsatz in die Diätplanung, stellt dies die sicherste und konsequenteste Vorgehensweise im Bereich der Ernährungstherapie dar. Die


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Differenzierung der Stoffwechseltypen ist somit weniger für die Konzeption der Ernährungsrichtlinien entscheidend, als viel mehr für Auswahl und Staffelung der therapeutischen Interventionen. Jeder Stoffwechseltyp bringt andere Eigenschaften in Punkto Resistenz und Apoptosefähigkeit mit sich. Die Kenntnis dieser Eigenschaften und ihr permanentes Monitoring erlauben über den gesamten Therapieverlauf eine individualisierte und maximal effektive Therapieplanung.

## Systems-prevention and the "paleo concept" – a philosophy of life written by nature during the human evolution

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### Background

Within the last decades many attempts have been made to establish a system of lasting measures for preventive health in the society. Despite these efforts none of these projects has worked on a broad basis and for a longer time. There are several reasons for this phenomenon: traditional way of thinking, nonprofessional concepts, lack of money, wrong measures, fraud science and diverging interests of lobbying third parties, to name just a few.
Fortunately this unfortunate situation is going to change due to several new aspects that have appeared at the same time though from very different fields of the society. In the following text we shall describe these synergistic aspects which lead the way to a new and effective kind of prevention: systems-prevention. The content of systems-prevention is elegantly described in most of its parts by the "Paleolithic or stone age concept".

### Scientific news as basis for systems-prevention

Based on the unexpected results of the decoding of the human genome we had to learn that not the genes are ruling the cell function but the cell function is using the information of the DNA like a library just as it is necessary in the very moment. In consequence the new concept of epigenetics was discovered. This ingenious feature of our body allows us to induce inheritable changes in the reading of the unchanged DNA.
Furthermore our body is not a single being but a symbiotic community consisting of billions of human cells and trillions of bacteria, viruses and fungi distributed all over our body and above all in our gut: a microcosm in the macrocosm of the universe – organized in a unique manner. So it is no longer possible to practice medicine or prevention in a reductionist way. Instead we are challenged to develop a new holistic approach like it is done in systems-

biology to understand how our highly sophisticated and efficient body works as a part of the universe.
In addition after almost five decades of error and scientific fraud the "tale of the unhealthy fat" initiated by Ancel Keys and readily promoted by nutrition and pharmaceutical industries finally has collapsed in 2014: in most cases not fat makes us fat but the overload of carbohydrates in our food.
But we have to go a step further. It is not only the diet which has to be looked at in a holistic way. Nearly all aspects of lifestyle in modern civilized nations are subjected to changes. This altered environment is composed out of three different systems: 1. the ancient environment of mother nature, 2. the new man-made environment of civilization, 3. the environmental system of social bonding and culture.

## The nature deficit effect

Man as the highest rank of evolution is able to create tools and change his original environment as described above. Unfortunately this has resulted not only in an exposure of his body to non-historical elements but also in a loss of natural resources. It is just the combined effect of these two synergistic negative aspects which is at the origin of noncommunicable diseases (NCD). So it is already widely accepted that the exposure to non-historical elements is leading to toxic effects, endocrine disruption and disturbed logistics in our body.
In contrast the scientific community is not aware that many of the natural resources for our body (like sunshine or work against the Earth's gravitational field) got lost for the majority of the population due to the technical progress of civilization. But these resources are needed for the highly complicated cell signaling of our body – our IT and logistic system including the immune system. Meanwhile almost 20 resources are known to be lost: This phenomenon we call the nature deficit effect. All together the missing factors massively change the complex function of our body - among others from effectively using the ability of epigenetic modulation of his DNA. To illustrate the fact that all these factors are influencing our IT system some examples shall be given in the presentation (micronutrients, Vitamin D, physical activity, n-3 fatty acids, fasting and social bonding).

## Conclusions

In Western countries, along with the progress in medicine and pharmacology, the reductionist approach helped to increase life expectancy. However, despite 40 years of research, epidemics of obesity, diabetes and cancer are growing each year worldwide, both in developed and developing countries, leading to a decrease in healthy life years. Based on the aforementioned insights the prevention of NCD needs a new and holistic approach, a systems-prevention taking into account the influences of the surrounding systems (the human environment) and using a multi-factorial approach to overcome the nature deficit effect. This can be done by re-naturalizing the human environment


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according to the "paleo concept" – as far as this is still possible in the 21st century. If necessary certain natural factors which are too difficult to obtain/re-introduce in the technical environment will have to be substituted by intelligent solutions – as it has been shown already for physical activity and Vitamin D.

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