

# Evaluation of diet quality by means of the Healthy Eating Index and its modified variants

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## Summary

This article presents the Healthy Eating Index and its modified variants – the Alternate Healthy Eating Index, the Healthy Eating Index EPIC and the Healthy Eating Index NVS. These indices are used to evaluate and quantify diet quality. The article describes the structures of and differences between these indices. The original Healthy Eating Index is based on the Dietary Guidelines for Americans; the Healthy Eating Index EPIC and the Healthy Eating Index NVS are based on German dietary recommendations. The Alternate Healthy Eating Index adopts a structure which demonstrates the links between diet and certain chronic diseases.

**Keywords:** dietary indices, Healthy Eating Index (HEI), Healthy Eating Index EPIC, Healthy Eating Index NVS, Alternate Healthy Eating Index, diet quality

## Introduction

The evaluation and quantification of the health quality of various diets is often challenging, yet these processes are essential for the investigation of a number of issues in nutritional science. There are a wide variety of dietary indices which attempt to quantify the physiological quality of the diet through a number of different approaches.

One of the most popular indices is the Healthy Eating Index (HEI),

which was originally developed by the U. S. Department of Agriculture (USDA) and is based on the Dietary Guidelines for Americans (DGAs). Other variants of the HEI have also been developed; these use a similar structure to the HEI, but rely on alternative bases for evaluation instead of the DGAs.

This article will present the original HEI as well as the Alternate Healthy Eating Index, the Healthy Eating Index EPIC and the Healthy Eating Index NVS.

## Original Healthy Eating Index

The Healthy Eating Index (HEI) records and evaluates diet quality by way of a summary value. The higher the HEI value, the more the dietary behavior corresponds to the American Dietary Guidelines and should thus reflect healthy dietary behavior [1]. The original HEI was developed in 1995 by the USDA

Center for Nutrition Policy and Promotion and has been revised twice since then. In 2006 the index was adjusted to the DGAs published in 2005 and in 2012 to the new DGAs of 2010 [2]. The latest version, the Healthy Eating Index 2010 (HEI-2010), and its amendments are described in detail below.

## Structure of HEI-2010

The HEI-2010 comprises twelve components (♦ Overview 1), in which a maximum point value of between 5 and 20 can be attained depending on the category. The more consumption corresponds to dietary recommendations, the higher the point value in each category. A total of 100 points can be attained by adding up these individual values [3].

As can be seen in ♦ Table 1, the HEI-2010 has two main categories – adequacy and moderation. The adequacy category contains nine of the twelve components. In this category, increasing consumption results in a higher score. If no food is consumed in one component, the component is given a value of zero; if the recommended quantity or more is consumed, the maximum point value is awarded. Only in the fatty acids component, which assesses the relationship between saturated and unsaturated fatty acids, does this evaluation slightly differ [3] (♦ Table 1).

In the three components listed in the moderation category, the index decreases with increasing consump-

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## OVERVIEW 1: INDIVIDUAL COMPONENTS OF THE HEI-2010

<b>total fruit</b>	This includes all consumed fruit, from apples to watermelons [6]. Fruit juice and canned fruit are also counted [3, 5]. The added sugar of canned fruit is recorded in the empty calories component [5].
<b>whole fruit</b>	This component only takes into account the consumption of fruit [3]. This also includes canned fruit. However, added sugar is counted in the empty calories component, as with total fruit [5]. Fruit juice is not counted [3].
<b>total vegetables</b>	Like the total fruit component, this component incorporates all consumed vegetables. This also includes legumes and dark-green vegetables, which are recorded again separately in the greens and beans component. If the recommended quantity in the total protein food component is not reached, legumes count in the total protein foods component – and not in the total vegetables component [3]. The consumption of vegetable juice is also included here [6].
<b>greens and beans</b>	This component records dark-green vegetables and legumes (beans and peas) [3]. Examples of dark-green vegetables include broccoli, rocket and chard [5]. Legumes are only listed if they have not already been recorded in the total protein foods component [3].
<b>whole grains</b>	This component records wholegrain products, i.e. foods made from the entire grain kernel (bran, germ and endosperm). Examples include wholegrain flour, oats and wholegrain rice [6], as well as bulgur wheat <sup>1</sup> and amaranth [5]. White flour (products) are not taken into account [6].
<b>dairy</b>	This component includes milk and dairy products, from liquid milk to yoghurts and cheeses. Soya drinks are also included [3].
<b>total protein foods</b>	All protein-rich foods such as meat, fish, eggs, as well as nuts, seeds and soya products like tofu are counted in this component [6]. As mentioned above, legumes are also taken into account, if the recommended quantity for this component is not otherwise reached [3].
<b>seafood and plant proteins</b>	This component includes fish and seafood, nuts, seeds and soya products (no soya drinks). If legumes are taken into account in the total protein foods component, they are also counted in this component [3]. This component was introduced because the DGAs of 2010 highlighted the healthy advantages of fish and seafood, which may replace a portion of meat and poultry. The advantages of a vegetarian diet are also emphasized in the DGAs of 2010. In order to ensure that a high index can also be attained for vegetarian or vegan diets, the HEI-2010 includes plant proteins from nuts and seeds in this separate seafood and plant proteins component alongside fish [3, 7].
<b>fatty acid</b>	This component evaluates the relationship between saturated and unsaturated fats. The maximum score is attained when the ratio of unsaturated to saturated fats is greater or equal to 2.5. This component was newly introduced in the HEI-2010, as the DGAs of 2010 emphasized that the type of consumed fats was more important than the quantity; saturated fats should be replaced by unsaturated fats [3, 7].
<b>refined grains</b>	This component incorporates highly refined grain products, i.e. products which do not contain all the elements of the grain, such as e.g. white flour, white bread or white rice [6]. Refined grains were introduced in the HEI-2010 as a new moderation component, because Americans consume too many highly refined grain products and intake should be limited through evaluation of the refined grains moderation component [3].
<b>sodium</b>	This component evaluates sodium respectively salt consumption.

**empty calories**      The empty calories component includes calories attained from solid fats, added sugars and alcohol [3].  
 Only sugars and syrups which are added to food and drink during the manufacturing process are counted as added sugar. This does not include sugar which occurs naturally in foods such as fruit or milk [8]. Solid fats include all fats which assume a solid state at room temperature. These are primarily animal fats, but also hard (e.g. palm oil) and hardened plant fats gained from the hydrogenation process. The fat in liquid milk also counts as a solid fat. However, this may not be immediately evident to consumers, as the solid form of fat is present in suspension due to the homogenization process [9]. Fat-free milk has no empty calories. Some meats also contain a high number of empty calories. E.g. although a roasted chicken leg with skin contains empty calories, a roasted chicken breast (without skin) contains none [10].  
 Alcohol consumption is also included in this component; but only if a minimum quantity of alcohol is exceeded (13 g ethanol/1,000 kcal) [3].

DGA = Dietary Guidelines for Americans; HEI = Healthy Eating Index

<sup>1</sup> Although bulgur wheat is not a wholegrain product, it is listed in the whole grains category in the original HEI.

Component	max. score	standard for max. point value	standard for point value of zero
<b>adequacy</b>			
total fruit	5	≥ 0.8 cup equivalent per 1,000 kcal	no fruit or juice
whole fruit	5	≥ 0.4 cup equivalent per 1,000 kcal	no fruit
total vegetables	5	≥ 1.1 cup equivalent per 1,000 kcal	no vegetables
greens and beans	5	≥ 0.2 cup equivalent per 1,000 kcal	no greens no beans or peas
whole grains	10	≥ 1.5 oz. equivalent per 1,000 kcal	no wholegrain products
dairy	10	≥ 1.3 cup equivalent per 1,000 kcal	no milk and dairy products
total protein foods	5	≥ 2.5 oz. equivalent per 1,000 kcal	no protein-rich foods
seafood and plant proteins	5	≥ 0.8 oz. equivalent per 1,000 kcal	no fish no seafood no plant proteins
fatty acids	10	(PUFAs + MUFAs)/SFAs ≥ 2.5	(PUFAs + MUFAs)/SFAs ≤ 1.2
<b>moderation</b>			
refined grains	10	≤ 1.8 oz. equivalent per 1,000 kcal	≥ 4.3 oz. equivalent per 1,000 kcal
sodium	10	≤ 1.1 g per 1,000 kcal	≥ 2.0 g per 1,000 kcal
empty calories	20	≤ 19% of energy	≥ 50% of energy

Tab. 1: Components of the HEI-2010 (own illustration based on [3])

HEI = Healthy Eating Index; MUFA = monounsaturated fatty acids; oz. = ounce; PUFA = polyunsaturated fatty acids; SFA = saturated fatty acids

Component	max. score	standard for max. point value	standard for point value of zero
<b>evaluation principle: adequacy</b>			
vegetables	10	≥ 5 portions/day <sup>1</sup>	0 portions/day <sup>1</sup>
fruit	10	≥ 4 portions/day <sup>2</sup>	0 portions/day <sup>2</sup>
whole grains	10	75 g/day (women) 90 g/day (men)	0 g/day
nuts and legumes	10	≥ 1 portion/day <sup>3</sup>	0 portions/day <sup>3</sup>
long-chain (n-3) fats (EPA + DHA) <sup>7</sup>	10	250 mg/day	0 mg/day
PUFA <sup>8</sup>	10	≥ 10 % of energy	≤ 2 % of energy
<b>evaluation principle: moderation</b>			
sugar-sweetened beverages and fruit juice	10	0 portions/day <sup>4</sup>	≥ 1 portions/day <sup>4</sup>
red/processed meat	10	0 portions/day <sup>5</sup>	≥ 1.5 portions/day <sup>5</sup>
trans fat	10	≤ 0.5 % of energy	≥ 4 % of energy
alcohol	10	0.5–1.5 drinks/day <sup>6</sup> (women) 0.5–2 drinks/day <sup>6</sup> (men)	≥ 2.5 drinks/day <sup>6</sup> (women) ≥ 3.5 drinks/day <sup>6</sup> (men)
sodium	10	lowest decile	highest decile

Tab. 2: Die AHEI-2010-Komponenten (eigene Darstellung in Anlehnung [12])

AHEI = Alternate Healthy Eating Index; oz. = ounce (entpr. 28,35 g)

**Portion sizes:**

<sup>1</sup> 1 vegetable portion = 0.5 cup, green leaf vegetable = 1 cup; <sup>2</sup> 1 fruit portion = 1 medium-sized piece of fruit; berries = 0.5 cup; <sup>3</sup> 1 nuts portion = 1 oz.; peanut butter = 1 tablespoon; <sup>4</sup> 1 portion of sugared drinks and fruit juice = 8 oz.; <sup>5</sup> 1 portion of unprocessed meat = 4 oz.; processed meat = 1.5 oz.; <sup>6</sup> 1 portion of wine = 4 oz.; beer = 12 oz.; spirits = 1.5 oz.; <sup>7</sup> Omega-3 fatty acids (EPA = eicosapentaenoic acid, DHA = docosahexaenoic acid); <sup>8</sup> PUFA = polyunsaturated fatty acids

tion; the maximum point value is attained if the recommended quantity or less is consumed. These components relate to food groups which should only be consumed in limited quantities, such as salt or highly refined grain products [3].

Point values are calculated proportionally for consumed quantities which fall between the maximum and minimum levels of consumption. Recorded foods are assigned to the respective groups for evaluation. Mixed foods are divided into their individual ingredients and solid fats and added sugars are counted separately [3]. Quantities are measured in cups or ounces (oz.) and are compared to calorie content, i.e. to 1,000 kcal or proportionally to the recorded total calorie intake [3]. A cup is a measure of volume which corresponds to approx. 240 ml; 1 ounce equals 28.35 g [4]. Databases can be used to determine the weight of 1 cup or 1 ounce in grams for individual foods. Thus, approx. 80 g of

raw broccoli equals 1 cup, whereas 1 cup of raw carrots weighs approx. 125 g [5]. No universal conversion is possible; each type of food must be separately converted. Chopping methods should also be taken into account.

### Alternate Healthy Eating Index (AHEI)

Some studies showed that the HEI of 1995 could only be partially linked to some chronic diseases. McCULLOUGH et al. therefore developed the Alternate Healthy Eating Index (AHEI) in 2002. This index should have a stronger link to chronic diseases and should thus forecast risks better. The structure of the AHEI therefore primarily consists of food and nutrient groups linked to chronic diseases [11]. In 2012 the AHEI was revised and the Alternate Healthy Eating Index-2010 (AHEI-2010) was developed [12].

### Component groupings and points system

As shown in ♦ Table 2, the AHEI-2010 consists of eleven components, in each of which ten points can be attained, resulting in a maximum total score of 110 [12].

Although the AHEI-2010 makes no explicit division between adequacy and moderation, there are components in which the point value rises with increasing consumption up to a maximum score (adequacy principle) and components in which the points system works inversely (moderation principle). Components which follow the adequacy principle (e.g. vegetables, fruit, whole grains) contain foods whose consumption is linked to a reduction in the risk of disease. For example, only whole fruits are taken into account in the fruit category, as their consumption has a positive impact on the risk of cardiovascular diseases and some types of cancer [12]. In the

HEI-2010, juice is also taken into account in the total fruit component, yet in the AHEI-2010, this is counted in the sugar-sweetened beverages and fruit juice component, as it can increase the risk of diabetes mellitus type 2. The sugar-sweetened beverages and fruit juice component has a points system which operates inversely to consumption; this system is also used in the following components: red/processed meat, trans fat and alcohol [12]. The structure of the sodium component means that the maximum score is attained if consumption lies in the lowest decile and the minimum score if consumption lies in the highest decile [12].

### German variants of the Healthy Eating Index

#### Healthy Eating Index-EPIC (HEI-EPIC)

In addition to the original HEI based on American recommendations, there are other country-specific Healthy Eating Indices, which are based on the dietary recommenda-

tions of the respective countries. The authors VON RÜSTEN et al. designed the Healthy Eating Index-EPIC (HEI-EPIC) in 2008; unlike the original HEI, this index is based on German recommendations from *aid infodienst* (aid nutrition pyramid). As in the HEI-2010, compound foods are divided into their separate ingredients and assigned proportionally to the respective components [13]. This index was originally used to evaluate the diet quality of older persons as part of the EPIC Potsdam Study [13]. Differences are found in the component groupings and the type of points system.

#### Component groupings

As shown in ♦ Table 3, the HEI-EPIC comprises eight food groups, rather than twelve as in the HEI-2010. In contrast to the HEI-2010, the HEI-EPIC also takes into account the consumption of drinks; alcohol consumption is however not considered in the EPIC Study, as it is regarded as a lifestyle factor and not an element of diet. One portion of fruit or vegetable juice is assigned to the fruit or vegetable category

and only counts as a portion in the drinks component when the limit is exceeded [13]. In the original HEI-2010, juice is only recorded in the total fruit or total vegetable components and alcohol is recorded in the empty calories category above a minimum quantity. Other drinks consumption is disregarded [3].

#### Points system

As in the HEI-2010, the total score is compiled from the scores for each individual food category, whereby scores are calculated by way of comparison between recommended and actual consumption frequency. The maximum score is 80, but this can be surpassed if additional points are awarded. The levels of consumption are based on individual energy requirements [13].

Whereas the HEI-2010 contains a standard for maximum and minimum point values and intermediate points are calculated proportionally, the HEI-EPIC has only one standard per component. Intermediate point values are calculated using formulae described in the study [13].

Components	max. score	standard for max. point value
<b>evaluation principle: adequacy</b>		
drinks	10	≥ 6 portions/day <sup>1</sup>
vegetables	10	} max. 10 additional points possible
fruit	10	
<b>evaluation principle: mixture of adequacy and moderation</b>		
grains, grain products, potatoes	10	4 portions/day <sup>4</sup>
milk, dairy products	10	3 portions/day <sup>5</sup>
meat, processed meat, fish, eggs	10	1 portions/day <sup>6</sup>
fats and oils	10	2 portions/day <sup>7</sup>
<b>evaluation principle: moderation</b>		
sweets, fatty snacks	10	≤ 1 portion/day <sup>8</sup>

Tab. 3: Components of the HEI-EPIC (own illustration based on [13])

HEI = Healthy Eating Index

Portion sizes:

<sup>1</sup> 1 portion of water = 280 ml; juice = 100 ml; <sup>2</sup> 1 portion of vegetables = 140 g; <sup>3</sup> 1 portion of fruit = 125 g; <sup>4</sup> 1 portion of bread, grains (cereals) = 70 g (for women); 85 g (for men); potatoes, pasta, rice, grains (cooked) = 200 g (for women)/250 g (for men); <sup>5</sup> 1 portion of milk = 250 ml; yoghurt = 150 g; cheese = 30 g; <sup>6</sup> 1 portion of meat = 200 g; processed meat = 30 g; fish = 150–200 g; eggs = 2–3; <sup>7</sup> 1 portion of fats and oils = 18 g (for women); 20 g (for men); <sup>8</sup> 1 portion of sweets, fatty snacks = 220 kcal (for women); 270 kcal (for men)

Components	max. point score	standard for max. point value <sup>1</sup>
<b>evaluation principle: adequacy</b>		
fruit	10 (5 additional points possible)	≥ 250 g/day
vegetables	10 (5 additional points possible)	≥ 400 g/day
drinks	10	≥ 1,5 L/day
<b>evaluation principle: mixture of adequacy and moderation</b>		
grain, grain products, potatoes	10	350–560 g/day
milk, dairy products	10	2 portions/day <sup>2</sup>
fish	10	150–220 g/week
<b>evaluation principle: moderation</b>		
meat, meat products, processed meat	10	< 300–600 g/week
eggs	10	≤ 3 eggs i. e. ≤ 180 g/week
alcohol	10	women: ≤ 10 g ethanol/day men: ≤ 20 g ethanol/day
spreadable fats	10	≤ 15–30 g/day

Tab. 4: **Components of the HEI-NVS** (own illustration modelled on [14])

HEI = Healthy Eating Index; NVS = *Nationale Verzehrsstudie* (National Nutrition Survey)

<sup>1</sup> based on a healthy adult with a physical activity level (PAL) of 1.4

<sup>2</sup> Portion sizes: 200–250 g milk/yoghurt or 50–60 g cheese/fresh cheese

Although there is no explicit division of food groups into the categories of adequacy and moderation, the sweets and fatty snacks component adopts an inverse points system [13], as is also the case in the moderation components in the HEI-2010. This means that the score receives rises with decreasing consumption and the maximum score is attained through the consumption of the recommended quantities or less.

The HEI-2010 awards the maximum score for all adequacy components (exception: fatty acid) when the recommended quantities are reached or exceeded, however, this method only applies to the drinks, vegetables and fruit components in the HEI-EPIC. The authors of the HEI-EPIC have also enabled additional points to be awarded (at most 10), as they have assumed that, due to the low energy density and high nutrient content of fruit and vegetables, too high an energy balance is rarely reached even when the recommended quantities are exceeded [13]. For the remaining components, the

HEI-EPIC stipulates a reduction in the maximum score if the recommended maximum quantities are exceeded. This means that the score rises with consumption until the recommended quantity is reached, after which the maximum point value is reduced. This evaluation adopts a mixture of adequacy and moderation principles. The more the recommended consumption frequency is exceeded, the lower the score. This method of calculation was chosen because excessive consumption of these food groups can easily lead to a high energy balance [13].

### Healthy Eating Index-NVS (HEI-NVS)

The HEI-NVS is another German HEI, which is based on the original HEI of 1995 and the HEI-EPIC [14]. The HEI-NVS was designed to evaluate the diet quality of buyers purchasing organic and non-organic products on data from the *Nationale Verzehrsstudie II* (National Nutrition Survey) (NVS II). The recommendations of the German

Nutrition Society (DGE) were used as the basis for evaluation and ten food groups were established [14].

### Component groupings

◆ Table 4 illustrates the ten food components of the HEI-NVS with their corresponding standards. The vegetable component includes salad and pulses as well as raw and prepared vegetables. However, potatoes and other tubers are included in the grains component alongside grain products such as bread, cereals and biscuits. As in the HEI-EPIC, one portion of juice can be assigned to the fruit or vegetable component; otherwise juices are included in the drinks component [14].

### Points system

The HEI-NVS also adopts a points system which compares consumed and recommended food quantities. The fruit and vegetable components can contain 15 points each and all other components 10 points each, producing a total of 110 possible points. As in the HEI-EPIC, there is only one standard per component and intermediate point values are

calculated using formulae which are also used in the HEI-EPIC [14]. The type of points system is based on the HEI-EPIC, i.e. 10 points are awarded if the recommended quantities are reached in the fruit and vegetable components, and up to 5 additional points are available if this value is exceeded. As in the HEI-EPIC, this is meant to emphasize the health advantages of high fruit and vegetable consumption. In contrast, no additional points are awarded in the drinks component [14]. In the grains, milk and fish components, the point value rises to a max. 10 points if the recommended quantities are reached [14]. If the recommendations are exceeded, the point value falls again, as is the case in most of the components in the HEI-EPIC. This can be regarded as a mixture of adequacy and moderation. The meat, eggs, alcohol and spreadable fats components are evaluated like the sweets and fatty snacks component in the HEI-EPIC: If the recommendation is exceeded, an inverse points system applies, whereby the point value falls with further rising consumption [14], similar to the moderation components in the HEI-2010.

### Comparison between HEI-EPIC and HEI-NVS

♦ Table 5 offers a comparison between the HEI-NVS and the HEI-EPIC in terms of food components and points system (evaluation principle).

#### Component groupings

In terms of component groupings, the HEI-NVS places meat, fish and eggs in separate categories, whereas these groups are incorporated into one component in the HEI-EPIC. The HEI-EPIC therefore allows these animal products to be substituted for one another, while still producing a full score. Collating animal products into one component also means there is no distinction between meat and fish, which should be evaluated differently from a dietary perspective. The HEI-NVS also records the consumption of alcohol in the evaluation of diet quality, whereas this is not considered in the HEI-EPIC. On the other hand, the consumption of sweets and fatty snacks is only taken into account in the HEI-EPIC. Even fats are treated differently: The HEI-NVS only records spreadable fats in the evalua-

tion of diet quality, yet all fats are taken into account in the HEI-EPIC. The advantage of consuming unsaturated fats and the differences in fat qualities are not explicitly recognized in either index.

#### Points system

There are also differences in the points system. For example, the inverse points system (moderation principle) is used in four components (meat, eggs, alcohol, spreadable fats) in the HEI-NVS and in only one component (sweets and fatty snacks) in the HEI-EPIC. The use of the moderation principle means that zero consumption leads to a full score. This principle only applies to sweets and fatty snacks in the HEI-EPIC, yet to a total of four components in the HEI-NVS. A mixture of adequacy and moderation principles means that higher consumption of the respective foods initially increases diet quality, and then decreases it once a limit is exceeded. This type of evaluation is used in both indices for grains, milk and fish (in the HEI-EPIC in the form of meat, processed meat, fish, eggs). The HEI-EPIC also applies this principle to fat consumption.

HEI-NVS		HEI-EPIC	
components	evaluation principle	components	evaluation principle
fruit	adequacy	fruit	adequacy
vegetables	adequacy	vegetables	adequacy
grains, grain products, potatoes	mixture	grains, grain products, potatoes	mixture
milk, dairy products	mixture	milk, dairy products	mixture
fish	mixture	meat, processed meat, fish, eggs	mixture
meat, meat products and processed meat	moderation		
eggs	moderation		
alcohol	moderation		
spreadable fats	moderation	fat, oils	mixture
drinks	adequacy	drinks	adequacy
		sweets, fatty snacks	moderation
<b>100 points (10 additional points available)</b>		<b>80 points (10 additional points available)</b>	

Tab. 5: Comparison: HEI-NVS and HEI-EPIC (own illustration based on [13, 14])  
HEI = Healthy Eating Index; NVS = Nationale Verzehrsstudie (National Nutrition Survey)

## Comparison between original HEI and German variants

Despite some similarities between the HEI-2010 and its German variants, there are also some differences. The advantages and disadvantages of the differences are highlighted below according to various criteria.

### Practicability

A major advantage of the HEI-2010 is that it provides comprehensive information which is helpful in the use of the index and its associated databases are freely accessible. These databases show which foods are divided into which components, and to what extent. However, conversion from grams into cups or ounces is required.

One problem in using the HEI-2010 is the differences in food choices between the USA and Germany. There are some foods, such as e.g. the comprehensive variety of bread types, which are not consumed in the USA and thus are not included in the databases, which complicates assignment.

In the German HEI-EPIC and the HEI-NVS, no conversion is required; however, the assignment of mixed foods into individual components is more laborious, as databases and further information are lacking.

### Component groupings

Differences in the indices are primarily due to a different choice of components, which can lead to incomparable results in the evaluation of diet quality. For example, drinks are taken into account in the HEI-NVS and the HEI-EPIC, but not in the HEI-2010. However, the HEI-2010 distinguishes between grain products, dividing whole-grain products and highly refined grain products, whereas this dis-

inction is not made in neither of the two German indices. The different diet quality of grain products is therefore not taken into account, even though this is regarded as significant according to DGE-Rule 2 [15]. DGE-Rule 5 [15] warns of hidden fats. Although this aspect of a wholesome diet is taken into account in the HEI-2010 in the form of solid fats in the empty calories component, it is not included in the HEI-NVS and is found only to a limited extent in the HEI-EPIC in the form of sweets and fatty snacks.

Greater significance is only attributed to the limited consumption of sugar and salt (DGE-Rule 6) [15] in the original HEI. Higher sugar consumption is negatively reflected in the empty calories component, and salt consumption has its own dedicated component. In contrast, salt consumption is not taken into account in neither of the two German indices and sugar consumption only to a limited extent in the HEI-EPIC in the sweets and fatty snacks component.

The negative evaluation of a high consumption of hidden sugars and fats is reflected by the empty calories component in the original HEI. However, the inclusion of this type of category requires comparatively more effort and therefore impairs the practicability of an index. There is a trade-off between accuracy and simplicity.

### Points system

Both the original HEI-2010 and its German variants have chosen the adequacy or moderation principles, depending on whether higher consumption is advantageous or disadvantageous. However, there are differences in the food groups which are assigned to each principle. In the HEI-2010, the moderation components include e.g. refined grain products, salt and empty calories, in the HEI-NVS e.g. meat and spreadable fats and in the HEI-EPIC only sweets and fatty snacks.

The German indices award additional points for food groups such as e.g. vegetables and fruit, for which consumption above the standard is positively rewarded through additional points. Another new addition is the mixed evaluation principle of adequacy and moderation, in which the point value falls again after the recommended quantity is exceeded, thereby "punishing" over-consumption.

### Links to diseases

Both the HEI-2010 and the AHEI-2010 have already been evaluated in a number of studies and correlations with diseases have been proven. However, many of the studies refer not to the HEI-2010, but to the earlier version, the HEI-2005. Links to diseases such as cardiovascular diseases, diabetes mellitus type 2 and some types of cancer have been demonstrated for the AHEI-2010 [16–20].

One study examined the HEI-EPIC to see whether it had links to cardiovascular diseases, diabetes mellitus type 2 and cancer [21]. An inverse relationship between the HEI-EPIC and cardiovascular diseases was however only observed among men. No links were proven for types of cancer. An inverse relationship between the HEI-EPIC and diabetes mellitus type 2 was demonstrated, yet was severely weakened by the inclusion of the Body Mass Index (BMI) [21]. The HEI-NVS has not yet been evaluated in relation to any possible links with diseases.

### Conclusion

This presentation of the four indices has illustrated the various possible approaches to carrying out point evaluations and selecting components. A points system which rises with consumption and the reverse are both conceivable, as is the



evaluation of over-consumption by means of decreasing point values, as is partially the case in the HEI-EPIC and HEI-NVS. In contrast, the AHEI-2010 is an example of how links between diet and certain chronic diseases can be shown through a different selection of components. These differences should be taken into account both in the interpretation and selection of indices for processing research questions. There are many other dietary indices in addition to the HEI and its modified variants. Due to the quantity and diversity of these indices, their respective strengths and weaknesses should be considered in detail in the preliminary stages of any research, in order to ensure that one or more suitable indices are chosen depending on the research goal.

#### Conflict of Interest

The authors declare no conflict of interest.

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#### References

- Center for Nutrition Policy and Promotion (1995) *The Healthy Eating Index*. URL: [www.cnpp.usda.gov/sites/default/files/healthy\\_eating\\_index/HEI89-90report.pdf](http://www.cnpp.usda.gov/sites/default/files/healthy_eating_index/HEI89-90report.pdf) Zugriff 05.03.15
- United States Department of Agriculture (2015) *Healthy Eating Index*. URL: [www.cnpp.usda.gov/HealthyEatingIndex](http://www.cnpp.usda.gov/HealthyEatingIndex) Zugriff 21.04.15
- Guenther PM, Casavale KO, Reedy J et al. (2013) *Update of the Healthy Eating Index: HEI-2010*. *J Acad Nutr Diet* 113: 569–580
- United States Census Bureau (2012): *Statistical Abstract of the United States - Weights and Measures*. URL: [www.census.gov/prod/2011pubs/12statab/app4.pdf](http://www.census.gov/prod/2011pubs/12statab/app4.pdf) Zugriff 16.06.15
- Bowman SA, Clemens JC, Friday JE et al. (2014) *Food patterns equivalents database 2011-12: methodology and user guide*. URL: [www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/fped/FPED\\_1112.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/fped/FPED_1112.pdf) Zugriff 19.05.15
- Guenther PM, Reedy J, Krebs-Smith SM et al. (2007) *Development and evaluation of the Healthy Eating Index-2005*. URL: [www.cnpp.usda.gov/sites/default/files/healthy\\_eating\\_index/HEI-2005TechnicalReport.pdf](http://www.cnpp.usda.gov/sites/default/files/healthy_eating_index/HEI-2005TechnicalReport.pdf) Zugriff 22.06.15
- United States Department of Agriculture and United States Department of Health and Human Services (2010) *Dietary Guidelines for Americans 2010*. URL: [www.cnpp.usda.gov/sites/default/files/dietary\\_guidelines\\_for\\_americans/PolicyDoc.pdf](http://www.cnpp.usda.gov/sites/default/files/dietary_guidelines_for_americans/PolicyDoc.pdf) Zugriff 02.06.15
- United States Department of Agriculture (2015) *What are added sugar?* URL: [www.choosemyplate.gov/weight-management-calories/calories/added-sugars.html](http://www.choosemyplate.gov/weight-management-calories/calories/added-sugars.html) Zugriff 21.04.15
- United States Department of Agriculture (2015) *What are solid fats?* URL: [www.choosemyplate.gov/weight-management-calories/calories/solid-fats.html](http://www.choosemyplate.gov/weight-management-calories/calories/solid-fats.html) Zugriff 21.04.15
- United States Department of Agriculture (2011) *How do I count empty calories?* URL: [www.choosemyplate.gov/weight-management-calories/calories/count-empty-calories.html](http://www.choosemyplate.gov/weight-management-calories/calories/count-empty-calories.html) Zugriff 21.04.15
- McCullough ML, Feskanich D, Stampfer MJ et al. (2002) *Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance*. *Am J Clin Nutr* 76: 1261–1271
- Chiuve SE, Fung TT, Rimm EB et al. (2012) *Alternative dietary indices both strongly predict risk of chronic disease*. *J Nutr* 142: 1009–1018
- von Rüsten A, Illner AK, Boeing H, Flothkötter M (2009) *Die Bewertung der Lebensmittelaufnahme mittels eines ‚Healthy Eating Index‘ (HEI-EPIC)*. *Ernährungs Umschau* 56: 450–456
- Wittig F, Hoffmann I (2010) *Ernährungsmuster von Bio-Käufern und Nicht-Bio-Käufern*. In: Hoffmann I, Spiller A (2010) *Auswertung der Daten der Nationalen Verzehrsstudie II (NVS II): eine integrierte verhaltens- und lebensstilbasierte Analyse des Bio-Konsums*. URL: [http://orgprints.org/18055/1/18055-08OE056\\_08OE069-MRI\\_uni-goettingen-hoffmann\\_spiller-2010-verzehrsstudie.pdf](http://orgprints.org/18055/1/18055-08OE056_08OE069-MRI_uni-goettingen-hoffmann_spiller-2010-verzehrsstudie.pdf) Zugriff: 18.12.15
- Deutsche Gesellschaft für Ernährung (2013) *Vollwertig essen und trinken nach den 10 Regeln der DGE*. URL: [www.dge.de/fileadmin/public/doc/fm/10-Regeln-der-DGE.pdf](http://www.dge.de/fileadmin/public/doc/fm/10-Regeln-der-DGE.pdf) Zugriff: 05.01.16
- Li S, Chiuve SE, Flint A et al. (2013) *Dietary quality and mortality among myocardial infarction survivors*. *JAMA Intern Med* 173: 1808–1818
- Fung TT, Kashambwa R, Sato K et al. (2014) *Post diagnosis diet quality and colorectal cancer survival in women*. *PLOS ONE* 9(12)
- Bosire C, Stampfer MJ, Subar AF et al. (2012) *Index-based dietary patterns and the risk of prostate cancer in the NIH-AARP-Diet and Health Study*. *Am J Epidemiol* 177: 504–513
- Jacobs S, Harmon BE, Boushey CJ et al. (2015) *A priori-defined diet quality indexes and risk of type 2 diabetes: the Multiethnic Cohort*. *Diabetologia* 58: 98–112
- Reedy J, Krebs-Smith SM, Miller PE et al. (2014) *Higher diet quality is associated with decreased risk of all-cause, cardiovascular disease, and cancer mortality among older adults*. *J Nutr* 144: 881–889
- von Ruesten A, Illner AK, Buijsse B et al. (2010) *Adherence to recommendations of the German food pyramid and risk of chronic diseases: results from the EPIC-Potsdam study*. *Eur J Clin Nutr* 64: 1251–1259

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