The Vita Score

An indicator for menus to minimize diet-related disease risks, based on the Global Burden of Disease Project.

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Table of content

1. Introduction

Today 229 million disease adjusted life years are lost to preventable non-communicable diseases through bad dietary habits. The aim of the Vita Score for meals is to promote a diet that reduces the risk of negative diet-related health outcomes such as cardiovascular diseases, diabetes and cancer. It was developed during the Health Footprint project in 2017 and made possible thanks to the support of the Engagement Migros development fund. It is based on and uses directly the data from the GBD project. The rule for the score is that the less points a meal gets, the more the meal contributes to good health, as one moves further away from bad dietary habits.

Many studies that investigate the healthiness of foods focus on supplying the appropriate amounts of nutrients needed to maintain a healthy (well-functioning) body. This approach is scientifically well founded. However, in most western countries diseases related to malnutrition are rare. Instead, diseases such as cardiovascular disorders, diabetes and cancer that are related to wrong dietary habits are more widespread.

The Global Burden of Disease (GBD) project quantifies, among others, the disease outcomes of bad dietary habits[1]. It is a collaboration of more than 1800 scientists and constitutes the largest epidemiologic study today. The World Health Organization (WHO) is an important partner and collaborator. The project aims to provide means for an informed debate towards better global human health. It is independently funded by the Bill and Melinda Gates Foundation.

The GBD project quantifies dietary disease outcomes of dietary risk factors into Disability Adjusted Life Years (DALYs) which depend on region (e.g. countries), gender and age. The dietary risk factors cover the intake of eight food groups, five macro- and micronutrients and fiber[2]. The risk factors and their outcomes (diseases) are based on epidemiological evidence, observational studies and randomized controlled trials[3].

2. Key elements of the Global Burden of Disease Project

2.1 Dietary risk factors
The dietary risk factors identified by the GBD project that contribute to disease are described in the Table 1. The critical levels of intake of these risk factors are defined per day and normalized for a 2000 kcal diet. High energy intake itself is not identified as a dietary risk factor by the GBD study. Therefore, it is not included in the Vita Score.

We categorized the risk factors into positive and negative ones. Positive risk factors are foods or nutrients of which we eat too little and we should eat more (e.g. vegetables). Negative risk factors are foods or nutrients of which we usually eat too much and we should eat less (e.g. salt).

The negative health outcomes (caused by the risk factors) are quantified by Disability Adjusted Life Years (DALYs). These are the years of life lost due to illness itself and premature death. With "health outcome" three groups of disorders linked to dietary risks are meant. These are: cardiovascular disorders, diabetes and neoplasms (cancers). Different risk factors are related to multiple diseases, which in turn account for different numbers of years of life lost (DALYs). The number of DALYs per risk factor depends on three things: how strong the link is between a risk factor and a certain disease, the occurrence and severity of a diseases in a given population and the gap between the ideal intake and the real consumption of a risk factor in the studied population.

To calculate the Vita Score the number of DALYs associated with a respective risk factor in a given population is used as a weighting factor (see Chapter 3.2).

The number of DALYs related to a risk factor is population specific and depends on age, gender and geographical location.

2.2 Exposure level and disease risk

For all risk factors have a theoretical minimum risk exposure level value (TMREL) has been estimated. It is defined as the level of risk exposure that minimizes disease risk at the population level. In other words, it defines the safe minimum or maximum daily intake of a food group or nutrient for a certain population. When the TMREL is reached or exceeded, it may have negative consequences for one's health. For example, diets with less than 250 g fruits / day (TMREL value) are associated with negative health outcomes.

The probability of the TRMEL value being reached or exceeded depends on the intake of a certain risk factor. The higher the probability, the higher the risk that a disease will occur. For the negative risk factors this means that the more we intake, the higher the risk is that the condition (disease with its burden expressed in DALYs) will occur (see Example 1a). Intakes that are below the lower boundary of the TMREL interval (T1), there is almost no disease risk (probability of reaching the real TMREL value is below 2.5%). For intakes higher than the upper boundary (T2) we can be almost certain that the real TMREL value has been reached and the risk condition takes place (probability of reaching the real TMREL value is almost 1).

In the GBD project it is defined that the risk condition takes place when the average TMREL value is reached (in the case of negative risk factors) or not reached (in the case of positive risk factors). For example, diets with less than 250g fruits / day (TMREL value) are associated with negative health outcomes. The TRMEL interval for diets low in fruits ranges between 200 and 300g / day. However, there are no extra benefits or problems associated with eating more or less than 250g of fruits per day.

TABLE 1. Dietary risk factors and their minimum risk exposure levels (TMREL) for a Swiss adult population (age between 15 - 49). The green highlighted risk factors are included in the calculation of the Vita Score.

Dietary risk factors	Definition	TMREL interval	TMREL value	Pos / neg
Diet low in fruits	Average daily consumption of fruits (fresh, frozen, cooked, canned, or dried, excluding fruit juices and salted or pickled fruits)	200-300 [g]	250 [g]	positive
Diet low in whole grains	Average daily consumption of whole grains (bran, germ, and endosperm in their natural proportion) from breakfast cereals, bread, rice, pasta, biscuits, muffins, tortillas, pancakes, and other sources	100-150 [g]	125 [g]	positive
Diet low in vegetables	Average daily consumption of vegetables (fresh, frozen, cooked, canned or dried vegetables including legumes but excluding salted or pickled vegetables, juices and starchy vegetables such as potatoes or corn)	340-500 [g]	420 [g]	positive
Diet low in nuts & seeds	Average daily consumption of nut and seeds	16-25 [g]	20 [g]	positive
Diet low in omega-3	Average daily intake of eicosapentaenoic acid and docosahexaenoic acid	200-300 [mg]	250 [mg]	positive
Diet low in fiber	Average daily intake of fiber from all sources, including fruits, vegetables, grains, legumes, and pulses	19-28 [g]	23 [g]	positive
Diet low in poly unsaturated fatty acids (PUFA)	Average daily intake of omega-6 fatty acids from all sources, mainly liquid vegetable oils, including soybean oil, corn oil, and safflower oil	9-13% of total energy	11% of total energy	positive
Diet low in calcium	Average daily intake of calcium from all sources, including milk, yogurt, and cheese	1-1.5 [g]	1.25 [g]	positive
Diet low in milk	Average daily consumption of milk, including non-fat, low-fat, and full-fat milk, excluding soy milk and other plant derivatives	350-520 [g]	435 [g]	positive

Dietary risk factors	Definition	TMREL interval	TMREL value	Pos / neg
Diet high in sodium (salt)	24 h urinary sodium measured in g per day	1-5 [g]	3 [g]	negative
Diet high in processed meat	Average daily consumption of meat preserved by smoking, curing, salting, or addition of chemical preservatives	0-4 [g]	2 [g]	negative
Diet high in trans fats	Average daily intake of trans fat from all sources, mainly partially hydrogenated vegetable oils and ruminant products	0-1% of total energy	0.5% of total energy	negative
Diet high in red meat	Average daily consumption of red meat (beef, pork, lamb, and goat but excluding poultry, fish, eggs, and all processed meats)	18-27 [g]	23 [g]	negative
Diet high in sweetened beverages	Average daily consumption of beverages with ≥50kcal per 226·8 g serving, including carbonated beverages, sodas, energy drinks, and fruit drinks, but excluding 100% fruit and vegetable juices	0-5 [g]	2.5 [g]	negative

3. Eaternity's Vita Score – summary of the most important aspects

3.1 Using the TMREL interval as a reference for daily intake

We have included 8 of the 14 risk factors to calculate the Vita Score (7 food-groups and salt). The reason for not including all risk factors is that there is a strong correlation between certain risk factors. For example, the risk factor "diets low in fiber" is already well covered by the risk factors on whole grains, fruits and vegetables as these food groups contain fibers abundantly[1]. Trans fats are considered additives and therefore, they could potentially be included in the Vita Score. However, we had to exclude them due to a lack of data in the available nutritional databases.

In the Vita Score the TMREL-interval of a risk factor is used as a reference for the recommended daily intake. For example, the TMREL-interval of vegetables ranges from 340g to 500g per day. All reference values calculated by the GBD project are given for a 2000 kcal intake per day. To evaluate, if a single meal or snack is in line with the daily recommendations, we can adjust the daily recommendations to the amount of kcal of the meal or snack under consideration. The main advantage of this procedure is that it treats meals or even smaller snacks without an unfair assumption that they have to fulfill the complete daily recommendations. More detail to this is given in Chapter 4.1.4.

3.2 Using weights for the risk factors

Most quantitative indicators that evaluate the healthiness of a diet or a meal treat all nutritional factors as equally important. This means that it is equally important to eat the right amount of fiber as well as the right amount of fat. Our underlying assumption is, that we do not have enough solid data to say which nutrient is more important when it comes to maintaining good health. All nutrients are important to keep our body's functioning properly.

In the GBD project however the dietary risk factors cause different health outcomes (disease and disease severity), whose consequences are expressed in the years of life lost by a population (DALYs). The number of DALYs vary for different risk factors, as well as for different countries, age groups and gender. As certain risk factors are associated

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[1] This overlap was explained by Prof. Dr. Ashkan Afshin, Lead of the Nutrition Group in the GBD project. The discussion took place on 12.07.2017.

with a higher disease burden, one can say that these dietary risk factors are more critical than others. In the Vita Score this information is integrated by using the number of DALYs related to a dietary risk factor as weighting factor to evaluate how much a meal contributes to a diet that reduces disease risk (for details see Chapter 4.1.5).

For example, diseases associated with high salt intake account for a specific amount of disability adjusted life years (DALYs) lost per 100'000 people in a given population. For a Swiss population (adults between 15 and 49 years of age) it is 45.88 DALYs per 100'000 people. Whereas, diets associated with low fruit intake account for 122.34 DALYs per 100'000 people in the same population. This means, that in the Vita Score a low intake of fruits is 2.5 times more important than a too high intake of salt for Swiss population between 15 and 49 years of age.

3.3 Using the TMREL-interval to model disease risk

In the GBD project it is assumed that disease burden related to a risk factor will occur as soon as the daily average TMREL-value is exceeded (for the negative risk factors) or not reached (for the positive risk factors). In the Vita Score, this binary approach is refined by modeling the exposure probability to increase linearly within the TRMEL interval (see Examples 1a and 1b).

Example 1a: TMREL interval and disease risk related to high salt intake (negative factor)

The TMREL interval for salt intake is between 1-5g (boundaries are marked by the dashed vertical lines). In the GBD studies, a population is exposed to the risk of getting diseases associated with high salt intake, when the consumption of salt is 3g or more per day (solid vertical line). The interval reflects that intakes below 1g salt per day (T1) is very unlikely to cause dietary diseases, while an intake above 5g salt per day is very likely to cause disease.
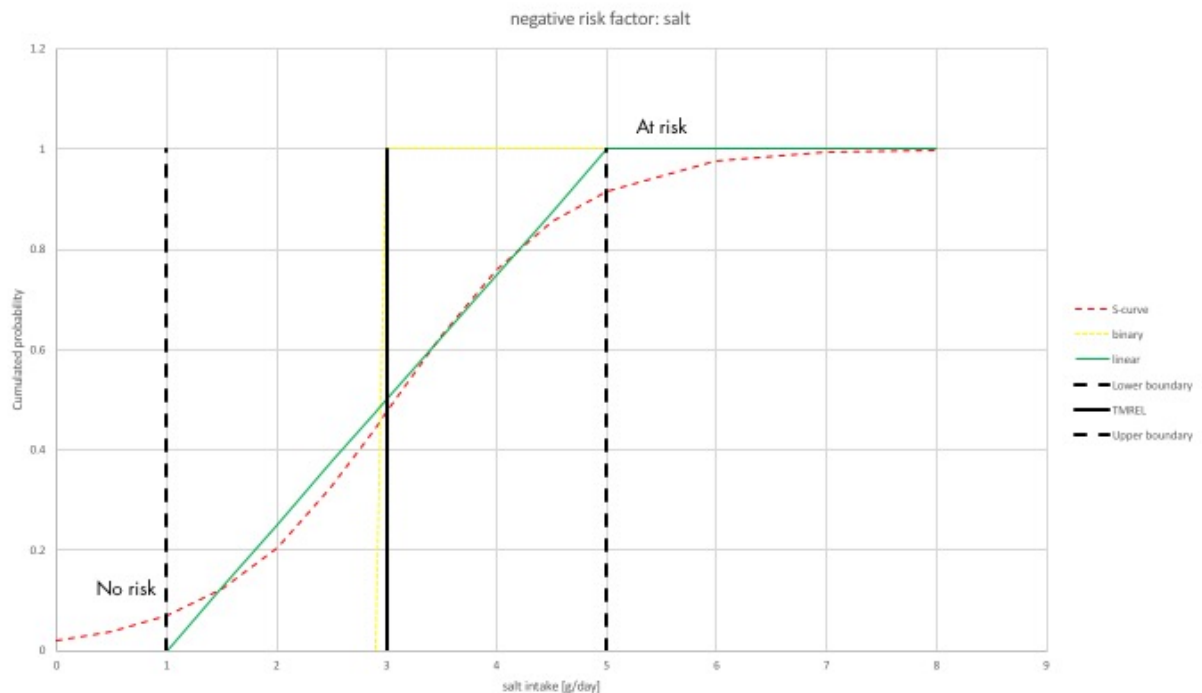
Example 1b: TMREL interval and risk for low fruits intake (positive factors)

The TMREL interval for fruit intake is between 200g and 300g of fruits (boundaries marked by dashed vertical lines). In the GBD studies, a population is exposed to the risk of getting diseases associated with low fruits intake, when the consumption of fruits is 250g or less per day (solid vertical line). The interval reflects that intakes below 200g of fruits per day (T1) is very likely to cause dietary diseases, while intake above 300g of fruits per day is very likely to cause no risk.
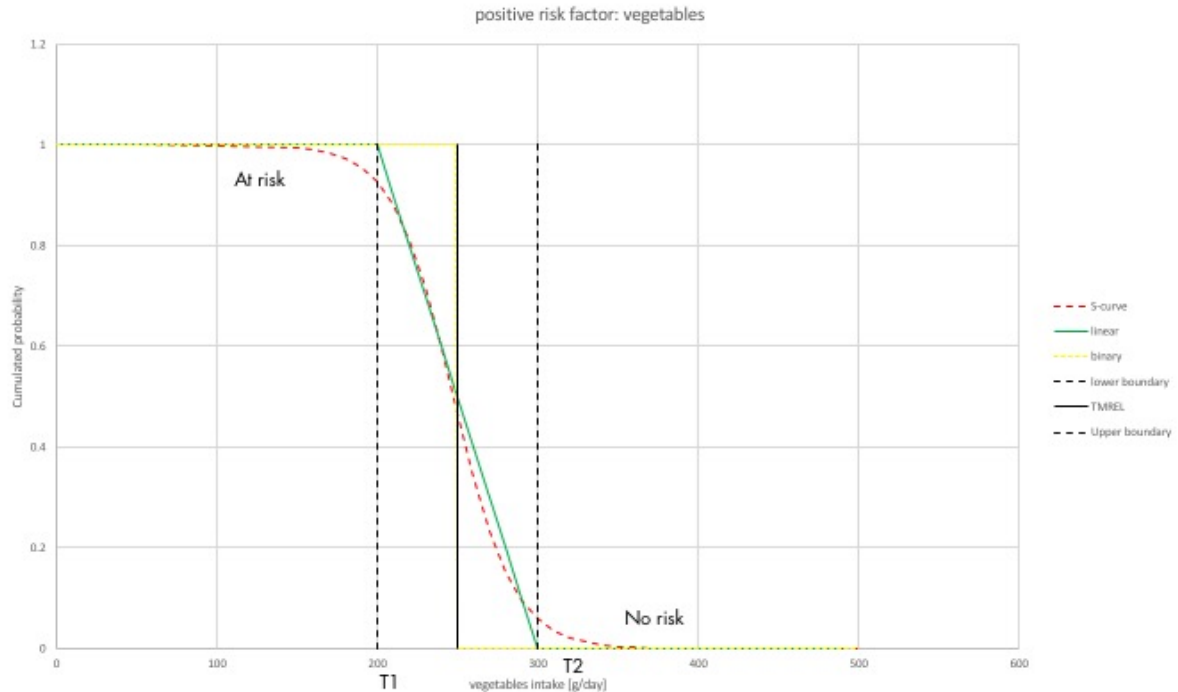
4. Formula of the Vita Score

4.1 Calculation of risk points per risk factor

To calculate the Vita Score of a meal risk points for every dietary risk factor are calculated and summed up. Each risk factor gets an initial score between 0 and 1 which depends on its intake. These points are then multiplied with their respective weight based on the amount of DALYs given by the GBD project. A calculation example is given below (Example 2).

4.1.1 Definition

The mathematical formula for the Vita Score consists of the following parts (the colors are related to the colors of the corresponding chapters in the document):

Weighting	The score for each risk factor is weighted with the associated DALYs (Chapter 4.1.5)
Limit values	Limits the unweighted score per risk factor between 0 and 1 (Chapter 4.1.4)
Slope	The score per risk factor increases linearly with increasing intake (Chapter 4.1.2)
Shift	Accounts for a meal being only a fraction of a daily kcal consumption (Chapter 4.1.3)

$$R(\cdot) = \sum_{r \in RF} RP_r(\cdot) \tag{1}$$

$$RP_r(x) = DALY_r \cdot \begin{cases} 1, f_r(x) \geq 1 \\ f_r(x), 0 < f_r(x) < 1 \\ 0, 0 \leq f_r(x) \end{cases} \tag{2}$$

$$f_{r,neg}(x) = \frac{x_r}{T_2 - T_1} - \frac{x_{kcal}}{2000} \cdot \frac{T_1}{T_2 - T_1} \tag{3a}$$

$$f_{r,pos}(x) = -\frac{x_r}{T_2 - T_1} + \frac{x_{kcal}}{2000}\left(1 + \frac{T_1}{T_2 - T_1}\right) \tag{3b}$$

The variables used in the formula are:

R	Vita Score for a meals recipe: •
RP_r	Risk points for a risk factor "r"
$f_r(x)$	Score before weighting (for either positive or negative risk factor)
$f_{r,pos}(x)$	Formula that calculates the score for a positive risk factor
$f_{r,neg}(x)$	Formula that calculates the score for a negative risk factor
x_r	Amount of intake of a risk factor "r"
T_1	Lower boundary of the TMREL interval
T_2	Upper boundary of the TMREL interval
$DALY_r$	Weight of the risk factor based on the Disability Adjusted Life Years lost for a risk factor "r"
x_{kcal}	Caloric content of the meal

Example 2: Calculating the Vita Score for a simple vegetable salad

For simple vegetables (portion of 350kcal) risk points for each risk factor are calculated and summed up to the final Vita Score (recipe: 200g of vegetables, 3.5g salt, no other products are used for simplification).

Risk Factor	T1	T2	Intake (Xr)	fr(x) (risk score)	DALYr (weight) (male & female, 15-49 yeas of age, CH)	Risk points
Diet low in fruits	200g	300g	0g	0.53	122	64.66
Diet low in vegetables	340g	500g	200g	0	88	0
Diet low in whole grains	100g	150g	0g	0.53	124	65.72
Diet low in nuts & seeds	16g	25g	0g	0.49	66	32.34
Diet low in milk	350g	520g	0g	0.54	8	4.32
Diet high in processed meat	0g	4g	0g	0	55	0
Diet high in red meat	18g	27g	0g	0	14	0
Diet high in sodium	1g	5g	3.5g	0.83	46	38.18
Vita Score					SUM	205.22

In the Example 2 some numbers might raise a few questions. Here is a short explanation.
- Vegetables: the cucumber salad consists mainly of cucumber (200g). It is in line with the recommendation for 350kcal and therefore it gets the minimal amount of risk points. So even when on a daily level the amount of vegetables is still below the lower boundary of the TMREL interval, adjusted for the number of calories, the meal contains a lot of vegetables.
- Salt: There are many risk points for salt, because the amount is too big for the caloric size of the salad. The upper boundary of the TMREL interval for salt is 5g (calculated for 2000kcal). For this small portion (only 350kcal) the proportional amount of salt should be maximal 0.88g. The 3.5g used in the example is much larger than that. The function ($f_{r,neg}(x)$) shows a value of 0.83.
- Fruits, whole grains, nuts & seeds and milk: even though these ingredients are lacking completely the risk score is not 1. The reason is that to derive the risk score the TMREL-interval is shifted to the kcal-adjusted upper boundary of a dish (see also 4.1.4). The reasoning behind this is that as this is only a small dish contributing to only a fraction of the daily energy needed, this dish should not get a risk score of 1 for these risk factors. You did not "ruin" your day yet, as you will probably eat more later as your energy requirement is much larger.

4.1.2 Vita Score derivation – use of the TMREL interval (slope)
The TMREL confidence interval has an upper (0.975) and a lower (0.025) boundary. Within this interval, the TMREL value is captured with 95% certainty.

A risk score between 0 and 1 is calculated per risk factor and depends on the level of intake and the TMREL interval. We use a linear slope to model the gradual increase of risk within the TMREL-interval instead of the one-value based binary switch used in the GBD studies. The reasoning behind this is that the closer one gets to an upper or lower boundary of the TMREL interval (upper for negative and lower for positive risk factors; see examples 1a and 1b), the higher the probability that the real TMREL value has been exceeded and the risk condition takes place. It therefore is a more accurate representation of the uncertainty of the TMREL value than a binary slope.

4.1.3 Vita Score derivation – limit the risk score to the TMREL interval (limit values)

The amount of food intake can lay outside the daily defined TMREL interval. It is possible to eat much more than the recommended intake or much less. There is no solid evidence that supports the assumption that if a person eats twice as much of the beneficial foods this is twice as healthy and further reduces the risk of getting ill. For this reason, we limit the risk score for any risk factor between 0 and 1. These boundaries are contained within the TRMEL interval neglecting the remaining 5% for simplicity.

In addition, there is no support for the assumption that we can compensate a "bad" food intake with a "good" food intake, for example (e.g. eating too much salt cannot be compensated with eating more whole grains). Not limiting the risk score per risk factor a high fruit intake could, for example, improve the Vita Score disproportionally and conceal a negative impact of a high salt intake.

At last limiting the risk score per risk factor between 0 and 1 corresponds to an estimation of the probability distribution of the TMREL value and the risk of a disease due to exposure, as defined by the GBD project (0 – average TMREL value not reached; no risk, 1 – average TMREL value reached; full risk).

Example 3: Different possibilities of limits (options a, b and c shown; for a meal of 2000kcal). Option a: no limit, the risk score can get any value. Option b: limits risk score between 0 and 1. Option c: limits risk score between -1 and 2. In the Vita Score calculation the risk score is limited between 0 and 1 (option b).
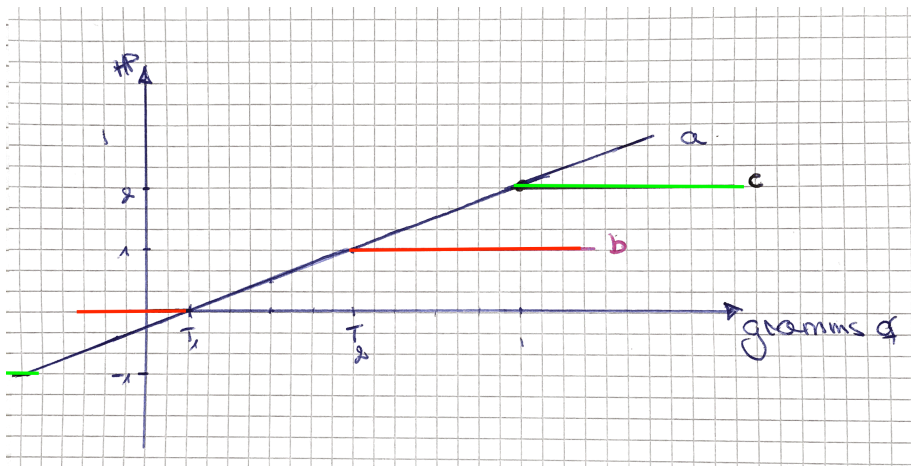
4.1.4 Vita Score derivation – allowing "smaller portions" (shift)

In the GBD project the TMREL intervals per risk factor are defined per day. The average daily energy intake in the GBD studies is set to 2000kcal. A meal or a snack is smaller than the daily consumption of energy. To evaluate the "healthiness" of a meal or snack we shift the TMREL interval. For the negative risk factors, we use the kcal-adjusted lower TMREL boundary (T1). For the positive factors, we use the kcal-adjusted upper TMREL boundary.

The main reason for not scaling with the calories both (the upper and the lower) TMREL boundary, is that this would change the length of the TMREL-interval and therefore the probability distribution of the TMREL-value. As described in chapter 2.2 the exact TMREL-value of a risk factor is unknown, but it lies with 95% certainty within the TMREL-interval. Adjusting both the upper and lower boundary to the amount of kcal of the meal or snack under consideration would in most cases shorten the length of the TMREL-. However, we decided to set the boundaries, while keeping the full length of the TMREL interval.

The following example illustrates the calculation of the risk score for salt (example of a negative risk factor) and vegetables (example of a positive risk factor) for a 1000kcal meal when the TMREL interval is shifted according to the caloric intake.

Salt
The lower boundary, T1 for salt equals1g. If the meal contains 1000kcal, the linear function is shifted to the left $f_r(x)$ = 0 for 0.5g of salt. Intakes higher than 0.5g of salt will lead to a risk score above 0. While intakes of salt below 1g are fine for the day perspective, the risk score given already for an intake above 0.5g will indicate that "if you continue with a similar intake of salt per calories, you may reach a critical intake by the end of the day".

The upper boundary, T2 for salt is 5g. This means that, for a 1000 kcal meal the TMREL interval is shifted and the upper intake of salt, T2 is adjusted to 4.5g. A meal with 1000kcal and 4.5g salt will yield $f_r(x)$ = 1. Even though the daily upper limit was not reached, the maximum number of risk points indicates "careful, you nearly reached the daily salt intake and, if you continue like this you will reach or even exceed the limit".

For 2.5g salt in a 1000kcal meal, half of the risk points are given ($f_r(x)$=0.5). The 2.5g salt correspond to the half of the recommended salt intake per day and it is a warning that if a person continues with the same salt intake per calories it will lead to the critical amount at the end of the day.

Vegetables
For vegetables, the upper TMREL boundary – T2, equals 500g. If a meal contains 1000kcal, the linear function is shifted to the left. So, the $f_r(x)$ = 0 is moved to 250g. Even though the minimum daily intake (340g) is not achieved yet, no risk points given. This gives the information that the person is "right on track" to fulfill the daily need for vegetables.

Consequently, the lower TMREL boundary – T1 is shifted to 90g. If a 1000kcal meal contains 90g of vegetables the maximum risk score of 1 is given. It is critical on a daily level because a person should only eat 1000kcal more, but at the same time still a lot of vegetables to reach the recommended daily minimum.

For 170g of vegetables in a 1000kcal meal, half of the risk points are given ($f_r(x)$=0.5). This means that half of the risk points is given and if a person continues with the same vegetables intake per calories, the person will fulfill the recommended minimum and won't be at risk.

4.1.5 Vita Score derivation - WEIGHTING (of each risk factor)
The question arises: are some of the risk factors are more important than the others. For example, is it more important to eat enough whole grains or not too much salt? From the GBD studies we see that different risk factors have different impacts on a population's health, as they are related to different amount of DALYs. For example, for the Swiss population (males and females between 15 and 49 years of age), a diet low in whole grains is responsible for 124 DALYs per 100'000 persons, whereas a diet high in salt is responsible for 46 DALYs per 100'000 persons). As described in chapter 3.2, because certain risk factors are associated with a higher disease burden, one can say that certain dietary risk factors are more important than others. To calculate the Vita Score the risk scores per risk factors are weighted by their corresponding number of DALYs. Through this, we include the information which of the risk factors contribute the most to the burden of disease (years of life lost) in a population and should be taken care of with priority.

4.2 Limitations of the Vita Score
The aim of the Vita Score is to minimize the risk of diet-related disease by steering against bad dietary habits. It does not evaluate if a meal or diet is balanced in the sense that it fulfills all daily nutrient recommendations to meet all physiological needs. For example, simply eliminating red meat from a diet and increasing the consumption of vegetables (e.g. salad and tomatoes) will not provide enough proteins, but it will improve the Vita Score. Further, the Vita Score itself does not provide information directly on whether a caloric intake is appropriate. For example, a dish with 2000kcal might still get a perfect score, but 2000kcal are most likely too much for a single meal.

The Vita Score can be used in addition to tools that evaluate the nutritional content of a meal to meet the daily nutrient recommendations as the information it provides has a different focus and aim and does not or only partially overlap. The main idea behind the score is that current common western diet provides our bodies with enough nutrients to keep them functioning, but it might negatively affect our health in general by contributing to diseases such as diabetes, cardiovascular diseases and different types of cancer.

Apart from the Vita Score also the nutritional values per person and portion are shown in the Eaternity Software. How much this portion fulfills the daily recommendation is given in percentages per nutrient. Since the convention states that an average warm meal should make one third of the recommended daily amount, those nutrients which go above this range will be clearly marked. This way also the nutritional content of a meal can be conveniently optimized.

Appendix 1 - Definitions

Being at risk
"Being at risk" as it is used in the current document means a possibility of being burdened by a disease.

Disability Adjusted Life Years (DALYs)
Overall disease burden. It is expressed as the number of years lost due to ill-health, disability or early death on a population level.

Negative risk factors
With negative (dietary) risk factors we mean those foods and substances, of which we usually eat too much and we should eat less.

Outcome (for health)
One of the three main disease groups identified by the GBD project in relation to the dietary risk factors. These groups are: cardiovascular disorders, diabetes and neoplasms (cancers).

Positive risk factors
With positive dietary risk factors, we mean those foods and substances, of which we usually eat too little and we should eat more (e.g. vegetables).

Risk factors
Potentially modifiable causes of disease and injury.

Risk points
Metric of the Vita Score. Points are obtained by summing the risk scores of all risk factors weighted with their respective number of DALYs.

Theoretical Minimum Risk Exposure Level (TMREL)
Level of exposure to a risk factor that minimizes risk at the population level. In other words, at what maximum or minimum intake of a risk factor a population has a minimal risk of becoming ill.

Uncertainty interval
A range of values that reflects the certainty of an estimate. Larger uncertainty intervals can result from limited data availability and conflicting data, while smaller uncertainty intervals can result from extensive data availability and data that are consistent across sources.

Vita Score
Final number of risk points obtained by summing up all the risk points of all the risk factors.

Appendix 2 - Global Burden of Disease Project (GBD)

The Vita Score is based on the data from the Global Burden of Disease Project, which shows the relationship between dietary risk factors (bad dietary habits) and different diseases.

The Global Burden of Diseases (GBD) project is at the Institute for Health Metrics and Evaluation and is affiliated with the University of Washington and funded by the Bill and Melinda Gates Foundation. It currently employs 300 staff members and has established a broad network of over 2000 collaborators worldwide. The goal of the GBD project is to bring up-to-date and the most detailed knowledge for researchers and policy makers on risk factors that contribute to disease. Their collaborative and open approach makes the project transparent and credible.

The GBD data and its methodological documentation are freely accessible. It includes global, regional, and country-level estimates for mortality, disability, disease burden, life expectancy, and risk factors. This data is the basis of our calculations. The data that the GBD uses to define and calculate the dietary risk factors and their outcomes is based on multiple sources including nationally and sub-nationally representative nutrition surveys, household budget surveys, United Nations FAO Food Balance Sheets and Supply and Utilization Accounts.

More information on the GBD project is available under http://www.healthdata.org/gbd.

Methodology of the GBD project

Disability Adjusted Life Years (DALY) is a measure of the disease burden in a given population. It is expressed as the number of years lost due to ill-health, disability or early death on a population level (given mostly per 100'000 persons). It can be thought of as a measurement of the gap between the current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability. The amount of DALYs related to a risk factor depend on population characteristics such as country, gender and age.

FIGURE 4. Graphical explanation of how DALYs are calculated.
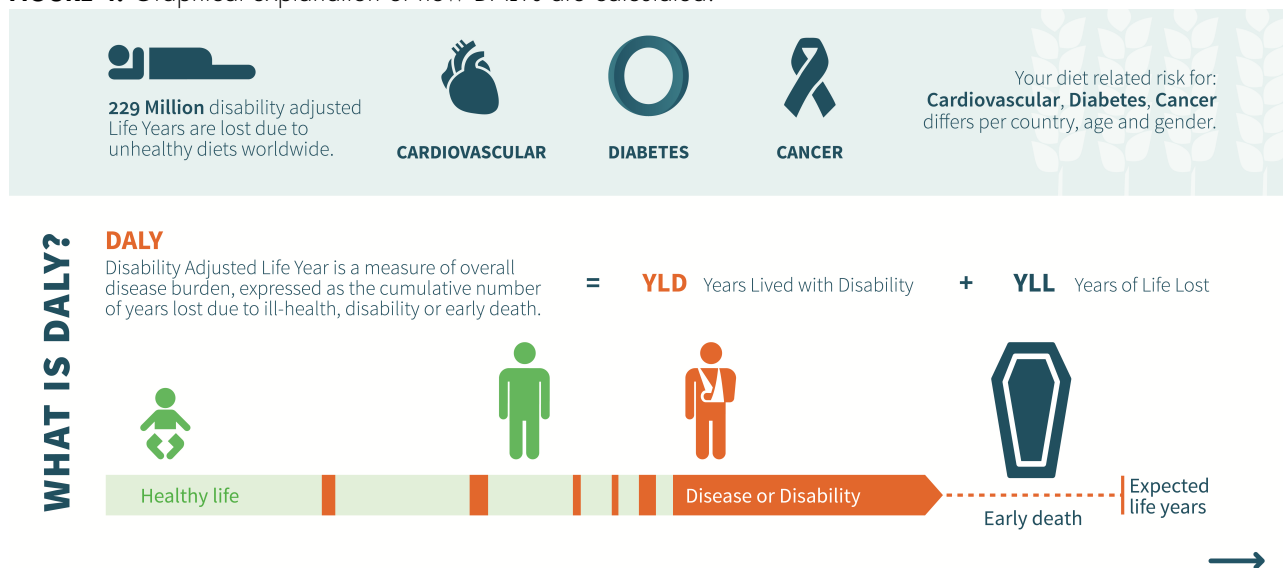
The amount of DALYs related to a risk factor are the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) by people that have to live the adverse health condition and its consequences (see Figure 1).

The amount of DALY per risk factor and disease is based on disease severity, the availability of sufficient data and the strength of the epidemiological evidence on causality and generalizability. The World Cancer Research Fund evidence grading criteria were used to assess the strength of the epidemiological evidence on the causal relationship between each risk factor and disease.

Theoretical Minimum Risk Exposure Level (TMREL)

In order to compute the amount of DALYs per risk factor, a theoretical minimum risk exposure level (TMREL) has to be computed. TMREL is defined which is the level of risk exposure that minimises risk at the population level, or the level of risk that captures the maximum attributable burden. TMREL was calculated based on peer-reviewed published studies and meta-analyses on the link between dietary habits and negative health outcomes, as well as on country specific diet, disease and death statistics of the dietary risks. The uncertainty of the TMREL-value is reflected in the 95% uncertainty intervals. This means that with 95% probability the real TMREL value is located within this interval.

DALYs for the dietary risk factors

TABLE 2. DALYs for the Swiss population between 15 and 49 years of age

Dietary risk factors	Definition	Both genders	Males	Females
Diet low in fruits	Average daily consumption of fruits (fresh, frozen, cooked, canned, or dried, excluding fruit juices and salted or pickled fruits)	124.19	169.89	77.39
Diet low in whole grains	Average daily consumption of whole grains (bran, germ, and endosperm in their natural proportion) from breakfast cereals, bread, rice, pasta, biscuits, muffins, tortillas, pancakes, and other sources	122.34	158.18	77.22
Diet low in vegetables	Average daily consumption of vegetables (fresh, frozen, cooked, canned or dried vegetables including legumes but excluding salted or pickled vegetables, juices, nuts and seeds, and starchy vegetables such as potatoes or corn)	88.25	131.58	43.71
Diet low in nuts & seeds	Average daily consumption of nut and seed foods	65.63	99.55	30.77
Diet low in omega-3	Average daily intake of eicosapentaenoic acid and docosahexaenoic acid	53.16	87.48	17.89
Diet low in fibre	Average daily intake of fibre from all sources, including fruits, vegetables, grains, legumes, and pulses	43.29	67.06	18.86
Diet low in poly unsaturated fatty acids (PUFA)	Average daily intake of omega-6 fatty acids from all sources, mainly liquid vegetable oils, including soybean oil, corn oil, and safflower oil	7.66	12.82	2.35
Diet low in calcium	Average daily intake of calcium from all sources, including milk, yogurt, and cheese	8.75	9.89	7.58
Diet low in milk	Average daily consumption of milk, including non-fat, low-fat, and full-fat milk, excluding soy milk and other plant derivatives	7.91	8.66	7.15
Diet high in sodium (salt)	24 h urinary sodium measured in g per day	45.88	74.27	16.68
Diet high in processed meat	Average daily consumption of meat preserved by smoking, curing, salting, or addition of chemical preservatives	55.44	76.37	33.95
Diet high in trans fats	Average daily intake of trans fat from all sources, mainly partially hydrogenated vegetable oils and ruminant products	20.8	33.37	7.88
Diet high in red meat	Average daily consumption of red meat (beef, pork, lamb, and goat but excluding poultry, fish, eggs, and all processed meats)	13.9	16.88	10.84

Dietary risk factors	Definition	Both genders	Males	Females
Diet high in sweetened beverages	Average daily consumption of beverages with ≥50kcal per 226·8 g serving, including carbonated beverages, sodas, energy drinks, and fruit drinks, but excluding 100% fruit and vegetable juices	3.45	4.87	2

References

1. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015

2. Forouzanfar, MH., et al., Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015, The Lancet 2015;388(10053):1659-1724

3. Adama Melaku Y., et al., The impact of dietary risk factors on the burden of non-communicable diseases in Ethiopia: findings from the Global Burden of Disease study 2013, International Journal of Behavioral Nutrition and Physical Activity 2016;1-13

4. Institute for Health Metrics and Evaluation (IHME). 2016. GBD Compare Data Visualization [Online]. Available: https://vizhub.healthdata.org/gbd-compare/ [Accessed 21.08.2017].

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