Vitamin status - a global perspective and impact on public health

The role and needs for micronutrients (fortification) is recognized in large parts of the world - however more needs to be done.

Provide objective assessment based on publicly available data and studies
We want to achieve a healthy diet for all

Current: Inadequate nutrient intake

1. Assess micronutrient intake & status in different regions/population groups
2. Explore impact on health and risk for nutrition-related diseases
3. Assess impact on health care and economic development
4. Advocate and facilitate fortification and supplementation programs

Future: Improved nutrition and health
Large-scale population-based dietary intake surveys taken into account

- **Nationale Verzehrsstudie II**
  7’093 men & 8’278 women
  Max Rubner-Institut; 2008

- **British National Diet and Nutrition Survey**
  628 men & 672 women
  Henderson L et al. (2003) Volume 3-
  Vitamin and Mineral intake and urinary analytes

- **Dutch National Food Consumption Survey 2007-2010**
  704 men & 698 women
  van Rossum CTM et al. (2011) Diet of children and adults aged 7 to 69 years

- **NHANES 2003-2008**
  3’944 men & 3’641 women
  U.S. Department of Health and Human Services & Centers for Disease Control and Prevention; 2009 [cited August 2010]. Available from:
Reality in micronutrient intake in Western countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Below Recommendation</th>
<th>Vitamin A</th>
<th>Vitamin B6</th>
<th>Vitamin C</th>
<th>Vitamin D</th>
<th>Vitamin E</th>
<th>Thiamin</th>
<th>Riboflavin</th>
<th>Niacin</th>
<th>Vitamin B3</th>
<th>Vitamin B12</th>
<th>Follic Acid</th>
<th>Vitamin C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>&gt;7.5%</td>
<td>Green</td>
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<tr>
<td>United Kingdom</td>
<td>&gt;7.5%</td>
<td>Red</td>
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<tr>
<td>The Netherlands</td>
<td>&gt;7.5%</td>
<td>Red</td>
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Nutrition related issues and diseases are on the rise

- 1.6 billion people overweight
- 366 mio with diabetes
- > 200 mio with osteoporosis
- 31 mio new cancer patients every year
- 32 mio new CVD cases every year

Total NCD mortality
- 36 of the 57 million global deaths in 2008 due to nutrition related diseases

- A major part, especially osteoporosis, diabetes, premature heart disease & stroke can be prevented
- Diet is an important modifiable factor

www.who.int/gho/ncd/en/index.html
Example Folate - different sources and functions

Food sources:
- Liver, green leafy vegetables, beans, wheat germ and yeast

Role in metabolic Reactions:
- Metabolism of amino acids
- Synthesis of nucleic acids (DNA and RNA)
- Formation of blood cells

Folate is essential for:
- Cell division
- Growth and functioning of the bone marrow

Deficiency risks:
- Neural tube defect (NTD)

Bloom et al., Nature, 2006 | VOLUME 7
Countries having mandatory fortification of food with folic acid (in red)

The following countries have mandatory fortification of food:

- Argentina
- Australia
- Bahrain
- Barbados
- Belize
- Bolivia
- Brazil
- Canada
- Chile
- Colombia
- Costa Rica
- Cote d'Ivoire
- Cuba
- Dominican Republic
- Ecuador
- El Salvador
- Fiji
- Ghana
- Grenada
- Guadalupe
- Guatemala
- Guyana
- Haiti
- Honduras
- Indonesia
- Iran
- Iraq
- Jamaica
- Jordan
- Kuwait
- Mexico
- Morocco
- New Zealand
- Nicaragua
- Oman
- Palestine, Occupied Territory
- Paraguay
- Puerto Rico
- Qatar
- Saudi Arabia
- South Africa
- St Vincent
- Sudan
- Turkmenistan
- Uruguay
- USA
- Yemen

http://www.eurocat-network.eu/preventionandriskfactors/folicacid/folicacidmandatoryfortification
The economic burden of Neural Tube Defects (Figures from recent cost calculations)

Babies born annually with NTD
- 300,000 to 400,000 worldwide (Christianson A, et al., (2006))
- ~4,500 in Europe (J Behav Med 25:411-424)
- 100,000 in China (N Engl J Med 341:1509-1519)

The impact and solution
- The average life time costs (including quality of life and life expectancy) for a child with an NTD amounts to: € 242,948
- Food fortification with folic acid is a cost effective and humanitarian countermeasure (Jentik et al. (2008))

In light of many countries experiences with folic acid fortification it is timely to advocate in countries with no fortification.

Several hundreds of millions Euros of savings were estimated as cost benefit for folic acid fortification - next to the ethical aspects
Example Vitamin D: impact on a number of body functions

Classical role of vitamin D: bone health
- Improves bone mineral density through calcium absorption and deposition
- Necessary to prevent rickets & osteomalacia

Emerging health benefits of vitamin D

Muscle:
- Reduces risk of falling by improving muscle strengths

Immunity:
- Strengthens the immune system
- Reduces risk of multiple sclerosis and diabetes type II

Cardiovascular:
- Lowers blood pressure

Cancer:
- Inhibits cell proliferation
Cost impact of low vitamin D status on fractures in Germany

Hip and vertebral fractures have the most „cost-intense“ medical implications

- Number osteoporosis patients: 8-10 mio (2010)*
- Number of hip and vertebral fractures p.a.: 150.000*

Optimized vitamin-D status reduces number of fractures by 20 %

- Reduction of 5,478 hip fractures and 18,420 less vertebral fractures (in osteoporosis-diagnosed population)

Net socio-economic benefit ranges from*:

Including medical and therapeutic costs for prevention, treatment and supplementation costs vitamin D up to

585 mio €

Including societal perspective, e.g. family care, reha costs

778 mio €

Source: * Sroll 2011
Magnitude of vitamin D considering additional health benefits

Risk reduction by optimal vitamin status:

- Bone fractures: 20%
- Cardiovascular Diseases: 20%
- Multiple Sclerosis: 50%
- Diabetes: 25%
- Cancer and others: 25%

Source: Grant et al. 2009
Large health care cost savings could be achieved with adequate vitamin D status

<table>
<thead>
<tr>
<th>Source/Study</th>
<th>Year</th>
<th>Region</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Zittermann</td>
<td>2010</td>
<td>Germany: overall perspective, including direct</td>
<td>€ 37,5 bn/y</td>
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<td></td>
<td></td>
<td>and indirect costs and implications</td>
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<tr>
<td>Grant et al</td>
<td>2009</td>
<td>17 countries in Europe: direct and indirect</td>
<td>€ 187 bn/y</td>
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<td></td>
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<td>cost savings (= 16.7% of total health care</td>
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<td>costs)</td>
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</table>

Adequate levels can be achieved with voluntary food fortification and/or supplementation for risk groups with costs of only 20-30 EUR/person per year

Source: vitamin D and socioeconomic costs, T. Sproll
A call to act on vitamin D deficiency

- 88% of the healthy population is below the optimal vitamin D status of 75 nmol/l 25(OH)D
- 37% below 50 nmol/l
- Specific groups like pregnant women, infants, elderly can be even more at risk

Regulatory bodies act
- US RDA tripled
- Europe 4-fold increase proposed
- India evaluation ongoing
- China evaluation ongoing
- Brazil evaluation ongoing
- ...

Nutritional solutions required
- Communication
- Food fortification
- Supplementation

DSM is engaged in human studies, with authorities and customers to fight vitamin D deficiency with innovative food solutions
In summary

- Vitamin deficiencies and inadequacies (examples folate and vitamin D) have detrimental health effect
- Solutions to address micronutrient deficiency and inadequacy are available and implemented in many countries
- DSM takes leadership in addressing societal needs in micronutrients
- Ensuring micronutrient adequacy is a cost effective approach for a healthy and productive life of billions

DSM has the competences and ingredients required for improving nutrition and is well positioned to develop this business further
Vitamin D comes from different sources
We evolved to make Vitamin D via sunlight (UVB) on the skin
UVB wavelength must be between 290-315 nanometer

25(OH)D serum level is the relevant indicator of Vitamin D status
(IOM 1997)

\[ \text{nmol/L} \]

- < 25: deficient
- 25 - 50: insufficient
- 50 - 75: inadequate
- > 75: desirable

\[ \text{ng/ml} \]

- < 10: deficient
- 10 - 20: insufficient
- 20 - 30: inadequate
- > 30: desirable