



## **The impact of vegan diet on health and growth of children and adolescents – Literature review**

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Unter supervision of Prof. Dr. Matthias Egger

# Introduction Relevance

Interest over time ?

Google Trends, 2016



3%  
Vegans



11%  
Vegetarians



17%  
Flexitarians



69%  
Meat eaters

DemoSCOPE, 2017: Survey on 1296 adults in the German and French speaking part of Switzerland

**Conclusion:** Mainstream-adoption of veganism. Relevant topic for public health.

# Methods

## Literature review

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- ▶ **Key variables:** Iron, calcium, vitamin D, folate, potassium and magnesium, selenium, weight and height.
- ▶ **Other variables:** Protein, n3-fatty acids, zinc, iodine
- ▶ **Tools:** , , Reference list checking
- ▶ **Keywords:** “vegan\*” “strict vegetarian” “child” “children” “adolescents” “youths” in combination with above variables.



# Results

## Advantages and risks of vegan diets

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### ▶ Advantages

- ▶ Reduced risks (Melina, 2016)
  - ▶ Ischemic heart disease
  - ▶ Type 2 diabetes
  - ▶ Hypertension
  - ▶ Obesity
  - ▶ Certain types of cancer

### ▶ Risk

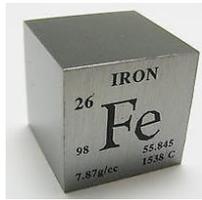
- ▶ Reduced intakes of critical nutrients



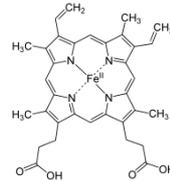
# Results

## Iron – Comparative data of adults

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### ▶ Heme vs. Non-heme iron



- ▶ Repeated observation (Haddad, 1999; Messina, 2001): **Vegans** have a lower ferritin level, but do not show higher rates of iron deficiency anemia than people in the general population.

### ▶ Schüpbach (2015) study on 206 Swiss adults:

#### ▶ Ferritin

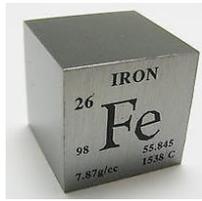
- ▶ Omnivores: 58; range = 3-463  $\mu\text{g/L}$
  - ▶ Vegans: 40; range = 9-277  $\mu\text{g/L}$ : n.s.
  - ▶ Vegetarians 32; range = 7-184  $\mu\text{g/L}$ : Sign. lower than omnivores
  - ▶ Iron deficiency: No differences between the groups.
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# Results

## Iron – Comparative data of children

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### ▶ Vegan children

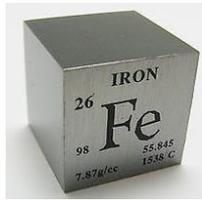
- ▶ Several studies show exceeding iron intakes.
- ▶ Ferritin levels: A master's thesis (Kim, 1988) with a vegetarian & vegan sample. Children aged 6-12 years. No sign. difference.
- ▶ A study (Nelson, 1994) of 44 vegetarian girls (including 2 vegan girls) 11-14 years of age. No sign. difference in regard to iron deficiency compared to omnivores.



# Results

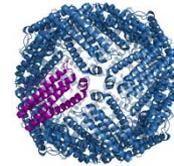
## Iron – Mechanisms

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### ▶ Adaptive mechanisms

- ▶ Low iron intakes over time -> Reduced iron losses (Hunt, 1999)
- ▶ Habituation to non-heme iron -> +40% uptake after 10 weeks (Hunt, 2000)
- ▶ Deficiency: 10-fold increase of absorption rate (Zielińska, 2015)
- ▶ New: Direct absorption of plant ferritin via endocytosis (Zielińska, 2015)



### ▶ Promotion

- ▶ Vitamin C
- ▶ Lysine

### ▶ Inhibition

- ▶ Cocoa, coffee, green/black tea
- ▶ **Dairy:** Casein, calcium
- ▶ **Eggs:** Protein

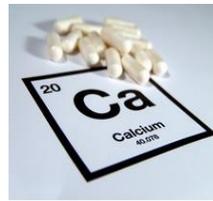
- ▶ **Conclusion:** Vegans have higher serum ferritin than vegetarians. No increased risk of iron deficiency in vegetarians or vegans.



# Results

## Calcium – Sources and intakes

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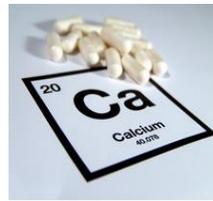
- ▶ Sources
    - ▶ Milk: 1250 mg/L (bioavailability 32%)
    - ▶ Fortified soy milk: Typically 1200 mg/L
    - ▶ Calcium-rich mineral water: 650 mg/L
    - ▶ Foods: Broccoli, kale. Bio-availabilities: 48%, 41%
  - ▶ Lower BMD in vegetarians (-2%) and vegans (-6%), but magnitude of the effect clinically insignificant (Ho-Pham, 2009).
  - ▶ Vegans not meeting intakes of >535 mg/D (44.5% of the sample) had a +30% risk of bone fractures (EPIC-Oxford).
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# Results

## Calcium – Data on children

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- ▶ Longitudinal study (Sanders, 1988): Vegan children had only 52% of recommended calcium intakes, however, growth was normal across the whole group.
- ▶ Surprisingly no deleterious effect of low calcium intake on bone health of young individuals (Matkovic, 2002).
- ▶ However: Maximize bone mineral density (BMD)!
  - ▶ Recommended intakes (Institute of Medicine (US), 2011):
    - ▶ 1-3 years: 700mg/day
    - ▶ 4-8 years: 1000mg/day
    - ▶ 9-18 years: 1300mg/day



# Results

## Cobalamin (Vitamin B12)

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- ▶ **Sources**
  - ▶ Meat, dairy, eggs
  - ▶ Certain algae: *Spirulina* spp., *Chlorella* spp.
  - ▶ Supplements or fortified foods or drinks



# Results

## Cobalamin – Status and supplementation

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- ▶ Around 50% of vegans are deficient in cobalamin.
  - ▶ Schüpbach, 2015: 43% of Swiss vegans used supplements.
    - ▶ USA 1999: 36% (Hallberg, 1991)
    - ▶ Sweden 2002: 37% (Larsson, 2002)
    - ▶ UK 2010: 19% (Gilsing, 2010)
    - ▶ Finland 2016: 73% (Elorinne, 2016)
    - ▶ Germany 2000: 6% (raw food vegans) (Donaldson, 2000)
  - ▶ Supplementation used in vegan children
    - ▶ 1988: ~ «Most» [sic!] -> >50%? (Sanders, 1988)
    - ▶ 1989: 76% (O'Connell, 1989, Fulton, 1980)
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# Results

## Cobalamin – Status of children

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- ▶ 48 children aged 2-5 years. Vegan since birth. 76% used supplements. No overt cases of deficiency reported (Fulton, 1980)
  - ▶ 32 vegetarian children (incl. 5 vegan children): Recommended intakes of vegan children not met, in the whole group regular serum concentrations (Ambroszkiewicz, 2006).
  - ▶ **Conclusion:** Supplementation rates insufficient, urgent need of improvement.
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# Results

## Weight

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- ▶ **EPIC Oxford** (Spencer, 2003). n=38'000 adults: **Weight in vegans (20-97 years)**
    - ▶ Males -6kg, females -5kg
    - ▶ 95% of the variance = diet
    - ▶ 5% of the variance = smoking, exercise
  - ▶ **Obesity and persistence into adulthood** (Sabaté, 2010).
    - ▶ Age 6 years -> 50%
    - ▶ Adolescence -> 70-80%
  - ▶ **Meat, fish, eggs, and especially dairy predict high BMI in children** (Sabaté, 2010).
  - ▶ **«The Farm» Study** (O'Connell, 1989) : 404 children aged 5 months to 10 years, 75% vegan.
    - ▶ 1.1kg lighter at ages 9 and 10.
  - ▶ **Conclusion: Limited data. Regular weight, possibly prevention of obesity.**
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# Results

## Height

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- ▶ Long-term study beginning in 1968 on 39 vegan children (Sanders, 1988): Regular height, weight, and head/chest circumference.
  - ▶ «The Farm» Study (O'Connell, 1989) : 404 children aged 5 months to 10 years, 75% vegan.
    - ▶ Smaller at young age (<5 years): -2.01 cm between 1-3 years, non-significant tendency for smaller height from after 5 years.
  - ▶ **Conclusion:** Limited data. Vegan children possibly smaller in stature.
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# Discussion

## Recommendations - International

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- ▶ **Academy of Nutrition and Dietetics** (former American Dietetic Association, 2016)
    - ▶ *“Vegan diets are appropriate for all stages of the life cycle, including pregnancy, lactation, infancy, childhood, adolescence, older adulthood, as well for athletes.”*
  - ▶ **European Society of Pediatric Gastroenterology, Hepatology and Nutrition**
    - ▶ *2008: “Infants and young children should not receive a vegan diet.”*
    - ▶ *2017: “Vegan diets should only be used under appropriate medical or dietetic supervision and parents should understand the serious consequences of failing to follow advice regarding supplementation of the diet.”*
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# Discussion

## Recommendations - Switzerland

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- ▶ Eidgenössische Ernährungskommission (2007)
  - ▶ *“During life stages such as pregnancy, growth and old-age only people with a large amount of nutritional knowledge can avoid deficiencies. This is hardly possible for laypeople.»*
    - ▶ Recommendation based on 4 publications on vegan children, of which 3 are not representative and focus only on cobalamin.
  - ▶ Revision in the works (2017)
- ▶ **Conclusion:** All known nutrients can be supplied with proper planning. But how often is this the case? Need for longitudinal studies.



# Acknowledgements

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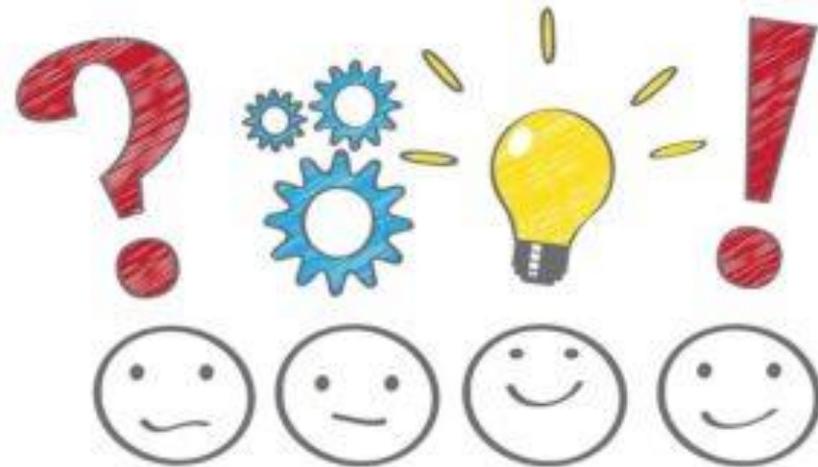
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Zurich**<sup>UZH</sup>

Institute of Evolutionary Medicine (IEM)



# Questions?

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- ▶ Unrestricted download of the entire thesis:  
[https://www.researchgate.net/profile/Daniel\\_Sutter](https://www.researchgate.net/profile/Daniel_Sutter)



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# Additional slides to answer questions

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# Potassium, Magnesium, Selenium

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## ▶ Potassium, Magnesium

- ▶ EPIC Oxford (Davey, 2003), n=65'429 adults
  - ▶ Vegans had highest intakes of potassium and magnesium.
- ▶ No data on vegan children available.

## ▶ Selenium

- ▶ Status dependend on soil.
- ▶ Dissertation (Hildbrand, 2015) (reference range: 80-120 µg/L).
  - ▶ Omnivores: 83.2 µg/L
  - ▶ Vegetarians: 68.9 µg/L
  - ▶ Vegans: 56.7 µg/L
- ▶ No data on vegan children available.





# Protein, n-3 fatty acids, zinc, iodine

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## ▶ Protein

- ▶ When caloric intake adequate: Vegan diets typically meet or exceed recommendations.

## ▶ n-3 fatty acids

- ▶ 40-50% lower blood and tissue concentrations of DHA and EPA in vegan adults.
- ▶ Stable levels via conversion from n-3 fatty acids.
- ▶ Micro-algae-based vegan DHA supplementation: Pregnant/lactating women or elderly vegans.

## ▶ Zinc

- ▶ Slightly reduced intakes, physiologically lower serum concentrations in vegan adults. No data on children.

## ▶ Iodine

- ▶ Problem in all populations -> Iodized salt or sea vegetables.
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# Growth effects of cow's milk

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- ▶ Cow's milk increases IGF-I (125) which in turn stimulates linear growth – in developing countries but also well-nourished populations in industrialized countries (127)
  - ▶ Authors reported that high milk consumption resulted in a 10% increase of circulating IGF-I in adults and a 20-30% increase of circulating IGF-I in children (126).
  - ▶ The Growing Up Today study, including 9'039 girls and 7'843 boys, all offspring of the women in the widely-known Nurses Health Study II (NHS II) cohort, showed that when comparing children drinking one glass or less per day with those drinking two glasses or more per day, girls drinking more were 1.3 cm taller and boys drinking more were 2.3 cm taller (130).
  - ▶ Doubling of per-capita cow's milk consumption between 1875 and 1900 -> 4 cm taller 19 year old army recruits (1920 compared to 1875).
  - ▶ Mechanisms: Micro-RNA -> Exosomes -> Intracellular metabolic pathways -> IGF, Insulin
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# Conclusions I

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- ▶ Vegan children can obtain all nutrients, given proper planning, including supplementation. But how often and under what circumstances is this the case?
- ▶ Further studies on vegan children needed
  - ▶ Criteria
    - ▶ Longitudinal studies
    - ▶ Measurement of supplementation and fortifications
    - ▶ Consideration of vegan sub-populations (e.g. Rastafarais, raw vegans)



# Conclusions II

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## ▶ Prevention

- ▶ Education of vegan parents regarding proper supplementation/fortification, especially regarding cobalamin, calcium, vitamin D, selenium (ANDERE?).
- ▶ Targeting of risk groups within the vegan population.

## ▶ Challenged positions

- ▶ Vegans are a homogenous group.
  - ▶ Vegetarians/vegans are a risk population for iron deficiency.
  - ▶ Informed laypeople are unable to follow a well-balanced vegan diet.
  - ▶ Direct outcomes like nutrients status or growth are the only relevant health outcomes in relation to dietary behavior.
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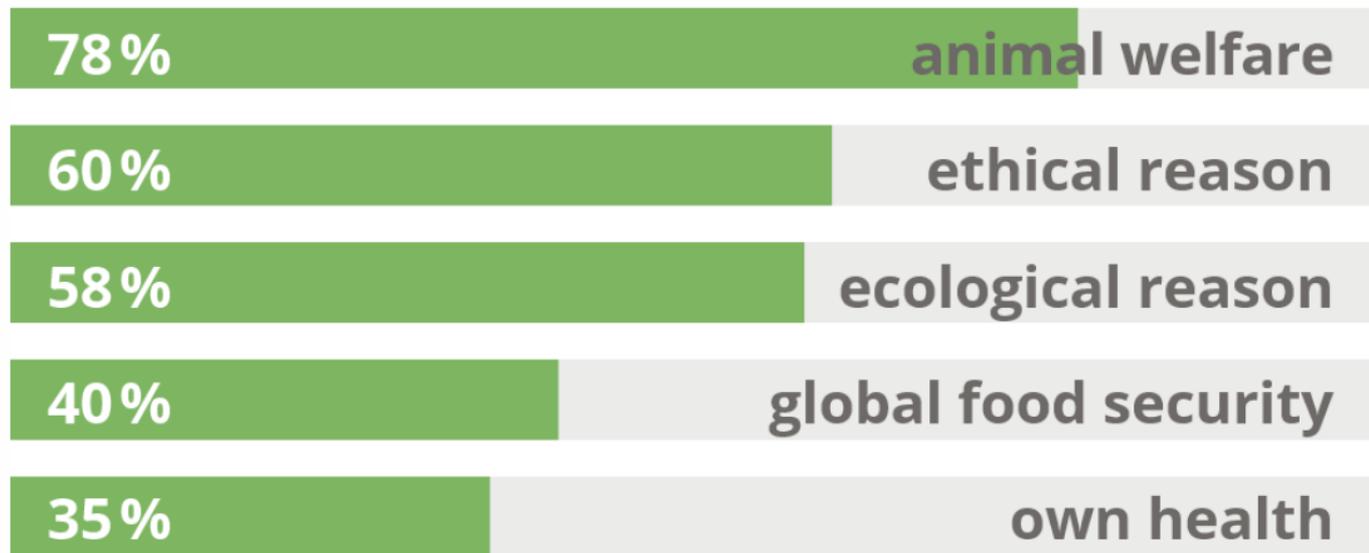


# Introduction

## Veganism

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- ▶ *“Veganism is a way of living which seeks to exclude, as far as is possible and practicable, all forms of exploitation of, and cruelty to, animals for food, clothing or any other purpose.”*



DemoSCOPE, 2017: Survey on 1296 adults in the German and French speaking part of Switzerland

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# Methods

## The KiGGS study

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Studie zur Gesundheit von Kindern  
und Jugendlichen in Deutschland

- ▶ Cross-sectional study
- ▶ Germany 2003-2006
- ▶ 17'652 (aged 0-17 years) children and their parents
  
- ▶ 57 children aged 1-17 years did not eat meat, fish, dairy or eggs. Presumed to be vegan.
- ▶ Large amount of available outcome variables.
  
- ▶ 2 Parts of my project:
  - ▶ Part I: Literature review of these outcomes in my master thesis
  - ▶ Part II: Statistical analysis in my dissertation



# Methods

## Study Populations

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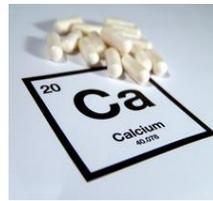
- ▶ **Obsolete groups**
    - ▶ Black hebrew / Hebrew israelite diets
      - ▶ „Multiple Nutritional Deficiencies in Infants From a Strict Vegetarian Community“ (Zmora, 1979)
    - ▶ Anthroposophic diet
    - ▶ Macrobiotic diet
      - ▶ “Vegetarian children: appropriate and inappropriate diets” (Jacobs, 1988)
  
  - ▶ **Types of vegan diets**
    - ▶ Standard vegan diet
    - ▶ «Natural» vegan diet
      - ▶ Rastafarian vegan diet
      - ▶ Raw vegan diet
  
  - ▶ **Conclusions**
    - ▶ Not all cited studies on vegans are de-facto vegan.
    - ▶ Vegans are not a homogenous group.
- 



# Results

## Calcium – Bone fracture risk

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- ▶ EPIC-Oxford study: Vegans aged 20-89 -> + 30% bone fractures.
  - ▶ Reason: Insufficient intakes
    - ▶ Vegans with <535mg/D intake (44.5%) -> + + Fracture risk
    - ▶ No increased risk in 55.5% of vegans (>535mg/D)
- ▶ **Meta-analysis** (Ho-Pham, 2009)
  - ▶ Lower BMD in vegetarians (-2%) and vegans (-6%), but the magnitude of the effect clinically insignificant.
    - ▶ Other factors more important
      - Physical activity: *Intense physical activity* -> -62% fractures
      - Alcohol: >2 glasses per day -> +23% fractures
      - Smoking: +25% fractures

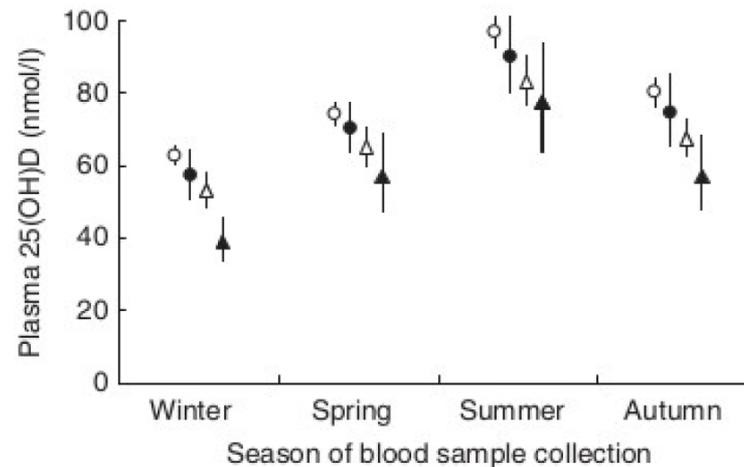


# Results

## Vitamin D



- ▶ Deficiency a widespread problem among all age groups of the general population.
- ▶ 90% is typically de-novo synthesized (UV-B radiation).
- ▶ 10% from food (liver, milk, eggs). Therefore, vegans have considerably lower dietary intakes.



*Crowe, 2011*

- ▶ No data on vegan children.
- ▶ **Conclusion:** Sun exposure crucial – if insufficient, supplements or fortification recommended.



# Results

## Folate

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- ▶ In adult Swiss, 58% are deficient (Schüpbach, 2015)
    - ▶ RR of vegetarians: 0.52 (30.2%)
    - ▶ RR of vegans: 0.22 (13%)
  - ▶ Germany, 2014: 35% of all children and adolescents have insufficient plasma levels, 15% are deficient (Moreno, 2014).
  - ▶ Evidence on vegan children: n=5 (surpassing allowances) (Ambroszkiewicz, 2006)
  - ▶ **Conclusion: Lower risk in vegan children, but supplementation still recommended.**
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# Discussion

## A broader view of dietary effects on health

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- ▶ Indirect health effects of animal farming
  - ▶ **Antibiotic resistance**
    - ▶ 2011: Multi-drug-resistant Staph. aureus in 25-50% of pigs and calves in Europe, Canada, and USA (Marshall, 2011)
      - Exit of resistant bacteria: Food, sewage.
      - Excretion of 75-90% of antibiotics.
  - ▶ **Zoonoses**
    - ▶ Influenza: e.g. 2009 H1N1 virus (Girard, 2010)
  - ▶ **World hunger**
    - ▶ *Farmland used to grow crops for livestock. 1 kg meat needs on average 10 kg of soy (Godfray, 2010).*
      - 75% of the world's soy -> Animal feed (WWF, 2017)
  - ▶ **Climate change** (McMichael, 2007, Carlsson, 2009, Hällström, 2015)
    - ▶ Rainforest deforestation: Production of soy for livestock
    - ▶ Production of methane by livestock.
- ▶ Adverse effects on animals
  - ▶ **Factory farming**
  - ▶ **Lethal violence necessary**

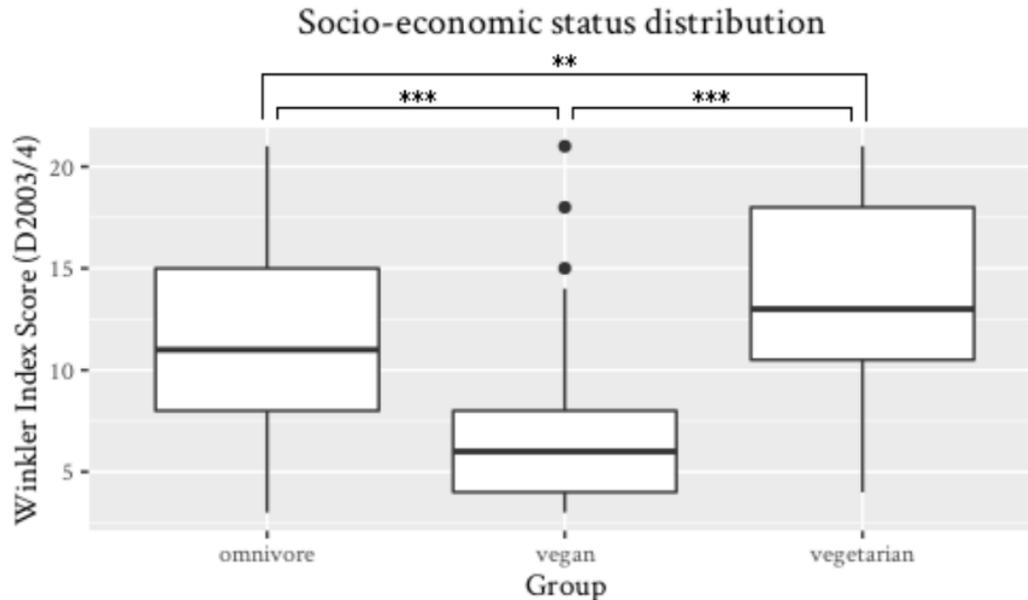


# Outlook

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## ▶ Statistical analysis / Dissertation

- ▶ Parents in lowest socio-economic layer. But vegetarians are typically well educated, and most vegans have been vegetarians first. Questionnable validity of the constructed group.





# Overview (abridged)

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- ▶ **Introduction**
  - ▶ Relevance
- ▶ **Methods**
  - ▶ Literature review
- ▶ **Results**
  - ▶ Advantages and risks of vegan diets
  - ▶ Selected Nutrients
    - ▶ Iron
    - ▶ Calcium
    - ▶ Vitamin D
    - ▶ Cobalamin
    - ▶ Folate
  - ▶ Weight & Height
- ▶ **Discussion**
  - ▶ Recommendations

