Why early prevention of childhood obesity is more than a medical concern-
A health economic approach

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Munich, 14 October 2016
Is childhood obesity a concern?
Future health and economic outcomes

**Prevalence of childhood obesity**

**Youth outcomes:**
- Morbidity
- Social and mental health
- Educational attainment

**Prevalence of adult obesity**

**Adult outcomes:**
- Morbidity and mortality
- Social and mental health
- Economic (job)
Overview

1. The economic burden of childhood overweight and obesity
2. Cost savings of interventions in early childhood
4. Conclusions
Direct and indirect costs due to ...

1) Increased **direct costs** = medical costs
   - out- and in-patient costs etc.

2) Increased **indirect costs**
   - parental absence at work due to sick children
   - psychosocial problems
   - school absence related with
     - lower skill attainment,
     - lower overall educational performance (quantity and quality of schooling)

  substantial later (work-related) productivity losses
Existing Cost-of-illness (COI-) Studies

1. Overweight/obesity in adulthood
   - **Prevalence-based** n=a lot, some from Germany:
     - Wolfenstetter (2012)
     - von Lengerke & Krauth (2011)
     - Konnopka et al. (2011)
   - **Incidence-based** n=some, none from Germany:
     - Yang & Hall (2008)
     - Tucker et al. (2006)

2. Taking childhood obesity into account
   - **Incidence-based** only one from USA/Germany:
     - Fernandes (2010)
     - Sonntag et al. (2015a, 2016)
Modelling lifetime costs of childhood overweight and obesity

CHILDREN
(Age: 3-17)

Model I
(epidemiology)

ADULTS
(Age: 18-75)

Model IIa
including normal weight children

Model IIb
including overweight and obese children
Modelling lifetime costs of childhood overweight and obesity

CHILDREN (Age: 3-17)

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Model IIa including normal weight children

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Modelling lifetime costs of childhood overweight and obesity

LEGEND:
- \( tp_{\text{no}} \): transition probability in normal weight to overweight
- \( tp_{\text{on}} \): transition probability overweight to normal weight
- \( tp_{\text{oa}} \): transition probability overweight to obese
- \( tp_{\text{Death}} \): mortality rate
- \( rr_\cdot \): relative mortality risk due to overweight and obesity

Source: Sonntag et al. 2015a, 2016
BMI trajectories taking the history of childhood obesity into account

Source: Sonntag et al. 2015a
Direct excess lifetime costs of childhood overweight and obesity

<table>
<thead>
<tr>
<th></th>
<th>Costs (€ 2010, without discounting)</th>
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<tbody>
<tr>
<td></td>
<td>Male</td>
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<tr>
<td>Overweight/obese as child</td>
<td>21,804</td>
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<tr>
<td>Normal weight as child</td>
<td>7,281</td>
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<tr>
<td><strong>Excess lifetime costs</strong></td>
<td><strong>14,524</strong></td>
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<tr>
<td>Cost increased by a factor of ...</td>
<td>3</td>
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<tr>
<td>Proportion of cost occur after the age of 60</td>
<td>0.67</td>
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Source: Sonntag et al. 2015a
## Direct excess lifetime costs of childhood overweight and obesity

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<tr>
<td>Overweight as child</td>
<td>5,824</td>
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<tr>
<td>Normal weight as child</td>
<td>1,562</td>
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<tr>
<td>Excess lifetime costs</td>
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<tr>
<td>Cost increased by a factor of ...</td>
<td>4</td>
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<tr>
<td>Proportion of cost occur after the age of 60</td>
<td>0.44</td>
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Source: Sonntag et al. 2015a
Direct excess lifetime costs of childhood overweight and obesity

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<tr>
<td>Normalgewichtig als Kind</td>
<td>1,955</td>
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<td><strong>Excess lifetime costs</strong></td>
<td><strong>4,209</strong></td>
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<td><strong>Cost increased by a factor of ...</strong></td>
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<td>Proportion of cost occur before the age of 60</td>
<td>3</td>
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<tr>
<td>Proportion of cost occur before the age of 60</td>
<td>0.81</td>
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Source: Sonntag et al. 2016
Indirect excess lifetime costs of childhood overweight and obesity

- Indirect costs due to childhood overweight
- Indirect costs due to childhood obesity
- Indirect costs due to adulthood overweight
- Indirect costs due to adulthood obesity
Economic burden of childhood overweight and obesity

- **Excess lifetime costs** of childhood overweight and obesity:
  - Male: €8,471
  - Female: €9,473

- **Total cost** for the current prevalent population in Germany: €1.8 billion.

Source: Sonntag et al. 2015a, 2016
Overview

1. The economic burden of childhood overweight and obesity
2. Cost savings of interventions in early childhood
4. Conclusions
Cost savings of interventions in early childhood

1. Preventive Programmes:

- Effects of most preventive programmes are small; short run treatment effects \((Yavuz\ 2015,\ Fröschl\ et\ al.\ 2009,\ Galani\ and\ Schneider\ 2006)\)

- Prevalence reduction by 1%

  - €4.1 million cost savings for the current prevalent population in Germany

Source: Sonntag et al. 2016
Cost savings of interventions in early childhood

2. EvAKuj-Study:

Prevalence reduction of 14% is potentially achievable

- indirect lifetime cost will be reduced by 4% (male) and 2% (female)

- €27 million cost savings for the current prevalent population in Germany (only indirect cost)

Source: Sonntag et al. 2016
Cost savings of interventions in early childhood

3. **Extreme Scenario:**
   prevalence reduction of overweight and obesity to the level of the 1990s

   ➔ €68 million cost savings for the current prevalent population in Germany (only indirect cost)

Source: Sonntag et al. 2016
Overview

1. The economic burden of childhood overweight and obesity

2. Cost savings of interventions in early childhood


4. Conclusions
(Cost-)Effectiveness of early prevention

Growing body of literature about **effectiveness** of early childhood intervention:

- Blake-Lomb et al. (2016): Interventions for Childhood Obesity in the First 1,000 Days: A Systematic Review.
Cost-effectiveness of early prevention

But what about cost-effectiveness of early prevention???
Cost-effectiveness of early prevention

- Only few health economic evaluations of interventions during childhood.
- Most studies assess the cost-effectiveness of school programmes (6-13 years) (Yavuz et al 2015).
- The majority of school programmes is cost-effective ➔ good value for money if cost of intervention are lower than 400$ and prevalence of obesity (overweight) has been reduced (increased) by 1% (Trasande 2010).
Cost-effectiveness of early prevention

Source: Heckman 2006
Cost-effectiveness of early prevention

However:

Only six international economic evaluations of early prevention programmes targeting preschool children and/or their parents were conducted!

3 main characteristics (Doering et al. 2016):

- Most programmes were cost-effective or even-cost saving despite insignificant effect sizes,
- Incremental-Cost-Effectiveness-Relations (ICER) differed substantially,
- Lifetime-perspective was chosen.
Cost-effectiveness of early prevention

- Few studies have assessed the cost-effectiveness of early prevention (<3 years), majority of studies focussed on USA (Yavuz et al. 2015, Batrick and Reinhold 2010)

- Economic evaluation is only based on cost while effects are not included ➔ partial economic evaluation.

- Compared to formula, significant cost savings of breastfeeding (€12,6 billion per year if 90% of U.S. women breastfeed) (Batrick and Reinhold 2010)

Need for future studies to assess the cost-effectiveness of early prevention!
Why the lack of economic evaluations?

3 major reasons ...

- Insignificant effect sizes, particularly when looking at long-term effectiveness.
- Conventional approaches to evaluate cost-effectiveness are of limited use given the complexity of childhood obesity and obesogenic environments.
- Today’s common practise:
  - Focus on implementation of programs while economic evaluations are often conducted after programs have been finished => retrospective economic evaluations tend to be imprecise.
Urgent need for **best-practise toolbox** for efficient data acquisition:

1. Involve health economists in design phase of an intervention:

   Since lifetime simulations require the measurement of longer run effects, the conduction of long-run interventions is needed.
Best-practise Guidance

2. Involve health economists to collect and administer data alongside the trial e.g. design of standardised questionnaires to collect primary data

- Standardised measurement of **clinical outcomes**
  - However, good economic evaluations require other outcomes like well-being (children?)

- Measurement of **cost** is still a major concern
  - Development of a cost tool is need (standardised measurement of direct and indirect cost before, during and after intervention)
Best-practise Guidance

3. Conduction of **pilot program**; adaption of questionaires if necessary

4. Health **economic monitoring** and assessment of intervention
   - Selection of parameter that measure effects?
   - Interpretation of health-economic results?
   - Validity (internal/external) of results?
   - Policy recommendations?
Economic Evaluation Process

Design
Design of intervention and construction of questionnaire(s)

Implementation

Intervention

Effects

Direct medical and non-medical cost
Indirect cost

ICER: $\Delta K_A - \Delta K_B$
$\Delta E_A - \Delta E_B$

Validity? Generalisability?
Overview

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Conclusions

- Transitions between overweight and obesity are particularly high in early childhood
  - early childhood seems crucial for preventive programs.
- Coordinate efforts between intervention developers, health care specialists and health economists in an effective fashion.
- Common use of best-practice toolbox for efficient data acquisition.


Literature (II)

• Trasande L. How much should we invest in preventing childhood obesity? *Health Affairs* 2010, 372-378.
Thanks a lot for your attention!
Additional Slides
Is childhood overweight and obesity a concern?

- Prevalence of overweight and obesity has nearly doubled in the last 20 years.
- In Europe: substantial increase over the last decade
- In Germany (based on KiGGS; children aged 3-16 years):
  - 6.2% overweight
  - 2.9% obese

- Probability to have excess weight...
  (Singh et al., Obesity Review 2008):
  - is the higher, the higher the weight during childhood.
  - Relative risk of children: appr. 2-10

- 30% of obese adults were obese as child
Modelling lifetime costs of childhood overweight and obesity

1. Obesity tracking from child- to adulthood

• Cohort is starting in age of 3 towards 17

• Markov cycle: 1 year

• Mortality rates are used from Federal Statistical Office

• Model additionally considers whether a child was normal weight or overweight before tracking into the next stage
2. Estimation of transition probabilities

- Kinder- und Jugendgesundheitssurvey (KiGGS): cross-sectional data
  - Adapting of health states “Normal weight“, “Overweight“ and “Obese”
  - Since data are not available for each year, data are adjusted by linear regressions
  - Determination of age- and gender-specific transition probabilities
Modelling lifetime costs of childhood overweight and obesity

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(Age: 3-17)

Model I
(epidemiology)

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(Age: 18-75)

Model Ila
including normal weight children

Model IIb
including overweight and obese children
Modelling lifetime costs of childhood overweight and obesity
Calculation of transition probabilities

\[
\alpha_{ji} = \frac{P(BMI_{i,t+1}) - P(BMI_{i,t})}{P(BMI_{j,t})}
\]

with \( j \neq i \), \hspace{1cm} (1)

where \( P(BMI_{i,t+1}) \) represents the prevalence of BMI category \( i \) at the age \( t+1 \),

\( P(BMI_{i,t}) \) represents the prevalence of BMI category \( i \) at age \( t \) and

\( P(BMI_{j,t}) \) represents the prevalence of BMI category \( j \) at age \( t \).
Calculation of transition probabilities

\[ \alpha_i = \frac{P(BMI_{i,t}) - P(BMI_{i,t+1})}{P(BMI_{i,t})} , \]  

where \( P(BMI_{i,t+1}) \) represents the prevalence of BMI category \( i \) at the age \( t+1 \), 
\( P(BMI_{i,t}) \) denotes the prevalence of BMI category \( i \) at age \( t \).
632 potential papers included into abstract review

10,584 papers excluded by title review

406 papers excluded by abstract review

226 potential papers included into full consideration

- 125 papers excluded due to non-German studies
- 43 papers excluded due to duplicates

58 German papers included into full-text review

52 papers excluded due to:
- 4 papers were systematic review without providing cost information
- 2 papers were focus on direct cost analysis
- 6 papers provided no economical data or indirect cost data
- 40 papers excluded due to irrelevant study information

6 papers included
<table>
<thead>
<tr>
<th>Reference</th>
<th>Site/Population size/Age</th>
<th>Method</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wolfenstetter et al.</td>
<td>Wolfenstetter et al.</td>
<td>Two-part regression model</td>
<td>The average total indirect cost per person for those who stayed at the same BMI class were €2,136 (Normalweight: 18.5&lt;BMI&lt;25), €2,909 (Overweight: 25&lt;BMI&lt;30) and €2,614 (Obese:BMI&gt;30). An overweight person who becomes obese incurred costs of €3,381 whereas an normalweight person who becomes overweight incurred costs of €2,473.</td>
</tr>
<tr>
<td>Breitfelder et al. (2011)</td>
<td>Munich, Wesel, Bad Honnef and Leipzig, 3,508, 9-&lt;12y</td>
<td>Two-part regression model, Population-Attributable Fraction (PAF)</td>
<td>Mean annual indirect costs were €100 (Normalweight: P10-P90), €85 (Overweight: &gt;P90 to P97) and €118 (Obese&gt;P97). Obesity causes €5,019 million in indirect costs, of which €646 million were due to sick absence, €992 million were due to early retirement and €3,381 million were due to mortality.</td>
</tr>
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<td>Konnopka et al. (2011)</td>
<td>Germany, 15-&gt;90y</td>
<td>Population-Attributable Fraction (PAF)</td>
<td>Obesity causes €328 million in indirect costs, of which €150 million were due to work loss, €112 million were due to disability and €67 million were due to mortality.</td>
</tr>
<tr>
<td>Sander and Bergemann (2003)</td>
<td>Germany, ≥ 25y</td>
<td>Population-Attributable Fraction (PAF)</td>
<td>Obesity causes €3,981 million in indirect costs, of which €504 million were due to sick absence, €605 million were due to early retirement, €2,710 million were due to mortality and €160 million were due to rehabilitation.</td>
</tr>
<tr>
<td>Bödemann (2010)</td>
<td>Germany, 15-90y</td>
<td>Population-Attributable Fraction (PAF)</td>
<td>Obesity cause €1,655 million direct cost, of which €582 million were due to disability, €760 million were due to inability to work and €313 million were due to mortality.</td>
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</tbody>
</table>
Modelling lifetime costs of childhood overweight and obesity

3. Further data

• Prevalence data are used from the Microcensus 2009

• Mortality rates are used from Federal Statistical Office

• In order to determine relative risks (RRs) two literature reviews have been conducted:
  - Age-specific mortality RR associated with obesity or overweight are used from the European Prospective Investigation into Cancer and Nutrition (EPIC-Study)
  - Adult mortality RR associated with obesity or overweight in childhood used from Adami (2008)
2. Costs

• systematic literature search (four electronic data bases, i.e., Medline, EconLit, National Health Service’s Economic Evaluation database (NHS EED), and the Cochrane Library).

• key terms “presenteeism”, “absenteeism”, “indirect costs” with “overweight”, “obesity” and “Germany”.

Modelling lifetime costs of childhood overweight and obesity
Lifetime costs of overweight and obesity

- high SES (obesity)
- high SES (overweight)
- middle SES (obesity)
- middle SES (overweight)
- low SES (obesity)
- low SES (overweight)
Comparison with other COI-studies

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<td>Proxy for incidence</td>
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<td>Markov Model</td>
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<td>Direct cost</td>
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<td>m</td>
<td>2.99</td>
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<td>f</td>
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<td>Indirect cost</td>
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<td>Incidence-based (long. Data SHARE)</td>
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<td>Micro-simulation</td>
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### Direct cost

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**Excess direct lifetime cost (discount 3%)**

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<td>13,840 for obese versus non-obese in adulthood</td>
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### Indirect cost

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Why the lack of economic evaluations?

- Today’s common practise:
  - Focus on implementation of programs while economic evaluations are often conducted after programs have been finished => retrospective economic evaluations tend to be imprecise.
  - Conduction of full economic evaluations of early prevention is patchy (most economic evaluations focus on costs while long-run effects are not measured).
  - How can we interpret results of economic evaluations? Are the results valid?