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# Health and Economy – Why We Need to Promote Physical Activity in Children

## *Gesundheit und Ökonomie – Warum wir körperliche Aktivität bei Kindern fördern sollten*

REVIEW

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### *Summary*

- **Non-communicable, chronic diseases** like type 2 diabetes, cardio-vascular diseases and cancer are meanwhile the most frequent causes of death and contribute to the rising costs in health care. The current focus on therapeutic procedures and medication requires more health promoting, preventive approaches to improve public health and thereby control costs. Decisions on measures that counteract rising costs in health care need to be evidence-based to ensure the responsible use of limited resources. This is accomplished by health-economic analyses of the cost-effectiveness of a measure, since both costs and effects are considered.
- **Physical inactivity** is one of the most crucial, modifiable risk factors of morbidity and mortality, therefore physical activity promoting interventions for schoolchildren should be first priority. In fact, although measures to promote physical activity in children are widespread, economic evaluations of these interventions are still very rare.
- **This review article** presents successful school-based interventions with proven cost-effectiveness. The assessment of cost-effectiveness is illustrated based on the examples of the German URMEL-ICE project and the "Join the Healthy Boat" health promotion programme. Both programmes were, with costs per child and year of €24.09 and €25.04 respectively, below the threshold of €123.24, determined by the parental willingness to pay.
- **A practical and sensitive outcome measure** for the determination of the effectiveness of a physical activity promoting intervention is the waist-to-height ratio (WHtR), a measure of abdominal obesity. Even without considerable weight loss, the exercise-induced reduction of abdominal fat mass generates health benefits.

### *Zusammenfassung*

- **Nicht-übertragbare, chronische Krankheiten** wie Typ-2-Diabetes, kardiovaskuläre Erkrankungen und Krebs sind mittlerweile die häufigsten Todesursachen weltweit und mitverantwortlich für den Kostenanstieg im Gesundheitswesen. Die bisherige Fokussierung auf therapeutische Prozeduren und Medikationen erfordert dringend mehr gesundheitsfördernde, präventive Ansätze, um die Gesundheit der Bevölkerung zu verbessern und dabei die Kosten zu kontrollieren. Entscheidungen über Maßnahmen, die dem Kostenanstieg entgegenwirken, müssen evidenzbasiert sein, um den verantwortungsvollen Umgang mit knappen Ressourcen sicherzustellen. Dies gelingt mit gesundheitsökonomischen Untersuchungen zur Kosten-Effektivität einer Maßnahme, da hier sowohl Kosten als auch Effekte betrachtet werden.
- **Körperliche Inaktivität** ist einer der wichtigsten veränderbaren Risikofaktoren für Morbidität und Mortalität, wobei Interventionen mit Bewegungsförderung für Schulkinder an vorderster Stelle stehen sollten. Tatsächlich sind bewegungsfördernde Maßnahmen für Kinder weit verbreitet, aber ökonomische Evaluationen dieser Interventionen sind sehr rar.
- **Diese Übersichtsarbeit** stellt erfolgreiche schulbasierte Interventionen mit nachgewiesener Kosten-Effektivität vor. Am Beispiel des URMEL-ICE-Projekts und des „Komm mit in das gesunde Boot"-Gesundheitsförderprogramms wird verdeutlicht, wie Kosten-Effektivität erfasst wird. Beide Programme liegen mit Kosten pro Kind und Jahr von €24,09 bzw. €25,04 unter der über die Zahlungsbereitschaft der Eltern ermittelten Kosten-Effektivitätsschwelle von €123,24.
- **Ein zweckmäßiges und sensibles Maß** für die Bestimmung der Effektivität einer bewegungsfördernden Intervention ist die Waist-to-Height Ratio (WHtR), ein Maß für abdominale Adipositas. Selbst ohne nennenswerte Gewichtsabnahme lassen sich durch die aktivitätsinduzierte Reduktion der abdominalen Fettmasse Vorteile für die Gesundheit erzielen.

KEY WORDS:
Cost-Effectiveness, Health Promotion, Exercise, Abdominal Obesity, Childhood

SCHLÜSSELWÖRTER:
Kosteneffektivität, Gesundheitsförderung, Bewegung, Abdominale Adipositas, Kindheit



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## Introduction

For many years, economies in developed countries have been confronted with increasing costs in their health care systems. The total expenditure on health, as a percentage of gross domestic product, has almost doubled in the Federal Republic of Germany from 6.0% in 1970 to 11.6% in 2009 (5.1% to 9.5% for all OECD countries) (33). The latest numbers were 9.0% for OECD countries and 11.1% for Germany in 2015 (provisional data) (34).

One of the main cost drivers are non-communicable diseases (NCDs) like cardiovascular disease, chronic respiratory disease, cancer, diabetes and mental illness. They pose a substantial economic burden and macroeconomic simulations suggest a cumulative output loss of US$47 trillion, representing 75% of global GDP in 2010, over the next two decades (2).

Table 1

Overview of the cost-effectiveness of programs enhancing physical activity of children at school. BMI=body mass index, CEA=cost-effectiveness analysis, CUA=cost-utility analysis, DALY=disability-adjusted life year, MVPA=moderate to vigorous physical activity, NRS=non-randomized study, QALY=quality-adjusted life year, PE=physical education, RCT=randomized controlled trial.

| PROGRAM<br>AUTHOR | INTERVENTION COMPONENTS | COUNTRY<br>STUDY-POPULATION | TARGET GROUP<br>NUMBER OF PARTICIPANTS<br>DURATION OF INTERVENTION | TIME-HORIZON FOR ANALYSIS | OUTCOME MEASURE | METHOD | RESULT<br>YEAR OF ASSESSMENT |
|---|---|---|---|---|---|---|---|
| **Fit for Pisa**<br>**Krauth et al. 2013** | Daily PE lessons | Germany | 6-10 years old<br>not specified<br>4 years | 4 years | BMI | NRS<br>CEA | € 236-619/student year<br>not specified |
| **Assessing Cost-Effectiveness in Obesity (ACE-Obesity) Walking Bus**<br>**Moodie et al. 2009** | Active transport to school | Australia<br>not specified | 5-7 years old<br>7,840 children reached<br>8 weeks/academic year | lifetime | BMI<br>DALY | Simulation modelling<br>CUA | AUD$ 760,000/DALY<br>2001 |
| **A Pilot Program for Lifestyle and Exercise (Apple)**<br>**McAuley et al. 2010** | Encouraging physical activity, nutrition, lessons | New Zealand<br>White, Maori, Pacific-Indians | 5-12 years old<br>n=151 intervention<br>n=136 control<br>2 years | 4 years | kg weight-gain<br>QALY | NRS<br>CEA | NZ$ 1,281/child<br>NZ$ 664-1,708/kg weight-gain prevented 2006 |
| **Medical College of Georgia FitKid Project**<br>**Wang et al. 2008** | After school MVPA physical activity, nutrition, lessons | USA<br>Afro-Americans, White, Hispanics, Asians | 8-11 years old<br>n=312 intervention<br>n=289 control<br>3 years | 1 year | % body-fat-reduction | RCT<br>CEA | US$ 558-956/student year<br>US$ 417/% body fat reduction<br>2003 |
| **Coordinated Approach to Child Health (CATCH)**<br>**Brown et al. 2007** | PE program, nutrition, lessons, family | USA<br>Hispanics, Mexiko-Americans | 8-11 years old<br>n=423 intervention<br>n=473 control<br>3 years | lifetime | overweight<br>QALY | RCT<br>modelling<br>CUA | US$900-903/QALY<br>2004 |

Health economy started looking at the expenditure side of health care measures years ago. The consideration of cost-effectiveness, which is already a common part of decision making procedures in Great Britain's National Institute for Health and Care Excellence (NICE) to include new health technologies in the benefits catalogue of the National Health Service (NHS) (38), does not yet play a major role in Germany. On the contrary, clinicians and practitioners complain about the "economisation of medicine", which they perceive as a limitation of their professional autonomy, therapeutic freedom and a hazard to ethical practice (36).

The aim of this review article is to take a closer look at early preventive measures in terms of youth physical activity promotion to encounter the double burden of the continuing increase of NCDs and the parallel rise in health expenditures. Thereby the focus of this article is set on economic aspects of physical activity and promotion efforts for good reasons: Many preventive and health promoting interventions are financed, and take place outside of the health sector. Due to limited financial resources, it is important for stakeholders and decision makers to identify interventions that are not only effective but are also cost-effective. Health economy will give support to decisions of resource use which aim to increase efficiency and welfare.

## Reasons for Increasing Costs in Health Care

The main reasons for the increase in health care expenditure can be summarised in three categories:

### Technological Advances and New Pharmaceuticals

New medical technology is a main driver of growth of health care expenditure. The available evidence which exists, suggests an overall impact of, on average, 50% on the increase in costs (40). Health economists complain about a considerable proportion of fake innovations (13), referring to drugs that are very similar to drugs which already exist. These "me-too" drugs diminish the incentives for innovation in pioneering drugs, without adding therapeutic value, but also absorb resources for research and development (17). The per capita expenditure for pharmaceuticals in Germany is 30% higher than the OECD average (35).

### Demographic Changes and Longevity

In high-income countries like Germany, the age structure of the population has changed significantly during the last 50 years. The proportion of under 20-years-olds in the entire population decreased from 28.4% in 1960 to 18.4% in 2010, while the over 60s rose from 17.4% to 26.3% (4). This trend is parallel to an increase in longevity. The life expectancy of a newborn in 1950 was 65 years, in 2010-2015 it is estimated to be 78 years, with a further upward trend (43). Older persons need more health care in general, and more specialized services due to their more complex pathologies (44). According to the German Federal Health Monitoring System (GBE), 48% of the total cost of illness in 2008 was incurred by patients aged 65 and older, in 2002 it was 43% (11).

### Epidemiological Changes and Changes in Lifestyle

Some of the epidemiological changes are due to demographic transition. An aging population brings an increase in chronic diseases, multi- and co-morbidities, functional impairments, and psychiatric disorders of the elderly (32). An increasingly unhealthy lifestyle has led to rising numbers of non-communicable diseases (NCDs), mainly diabetes, cardiovascular diseases, cancers, chronic respiratory diseases, and mental illnesses. NCDs pose an immense economic burden on health care systems and economies, and will rise to an estimated 25.5 trillion US$ (2010) in 2030 for high income countries (2).

## A Worldwide Threat: Non-Communicable Diseases

According to the World Health Organization (WHO), NCDs are estimated as accounting for 91% of all deaths in Germany (47). There is a strong contribution from physical inactivity; which is the fourth leading risk factor for mortality worldwide (41). The prevalence of physical inactivity as one of the main risk factors for NCDs was estimated at 30% for the total population in Germany in 2008 (48). Other modifiable behavioral risk factors include an unhealthy diet and the harmful use of alcohol and tobacco. These behaviors lead to metabolic/physiological changes that increase the risk of NCDs: raised blood pressure, overweight/obesity, hyperglycemia and hyperlipidemia (49). Elevated blood pressure is the leading metabolic risk factor globally in terms of attributable deaths, followed by overweight/ obesity and hyperglycemia (49).

Reasons for the rise in NCDs are predominantly secular changes in lifestyle and environment. The composition of the human diet has changed considerably, with globalization and urbanization making energy-dense processed foods cheaply and readily available. In Canada, for instance, the caloric share of processed food products rose from 28.7% to 61.7% between 1938 and 2011 with the greatest share being ultra-processed products (31). This fast food culture, together with a sedentary lifestyle, and increases in bodyweight is now known as the "globesity" epidemic (2).

## Boosting the Evidence-Base: Cost-Effectiveness

WHO released a global action plan for the prevention and control of NCDs. According to this plan, a vast body of knowledge and experience regarding the preventability of NCDs exists, and there are also immense opportunities to control them (50). The Washington State Institute for Public Policy recommends avoiding "spending money on programs where there is little evidence of program effectiveness. Shift these funds into successful programs." (46). To do so, policy makers need to receive information on both, the costs and the effectiveness of programs. Cost-effectiveness means a comparison of costs and benefits to analyze the economic efficiency of measures. Examples are; the costs per symptom-free day gained through a certain medication; or the costs per case of overweight/obesity averted through a preventive measure. The challenge is now to decide whether this number of costs per unit of health outcome reflects cost-effectiveness. Therefore, a threshold for cost-effectiveness is essential. The societal willingness to pay for specific improvements in health represents such a threshold.

Moreover, to make outcomes from different programs comparable across the boundaries of several disciplines or indications, a common measure for health outcomes is required. For that purpose, a health status index that combines duration and quality of life, afterwards called "quality adjusted life year" (QALY), was introduced in the early 1970s. Later on, in the early 1990s this concept was followed by the "disability adjusted life year" (DALY), which is primarily a measure of disease burden (39). Both concepts facilitate the comparison of health outcomes across disciplines. The QALY is used in most economic evaluations, especially where cost-effectiveness is requested in decision-making processes (39). The value of a QALY is not fixed, it is often set at US$50,000 in the US or up to £30,000 in the United Kingdom (8). To calculate the respective threshold of cost-effectiveness for the DALY, the WHO recommends the use of the gross domestic product (GDP). According to this definition, an intervention is supposed to be cost-effective if the costs for one averted DALY is below three times GDP per capita (51).

## Health-Economic Evaluation of Lifestyle Interventions in a School Setting

Despite the growing number of lifestyle interventions with the promotion of physical activity in schools, the number of economic evaluations remains manageable. Table 1 shows notable examples of economic evaluations of school-based programs from international literature. The depicted studies have been taken from a systematic review of programs encouraging physical ac-

Table 2

URMEL-ICE intervention effects. CI=confidence interval, BMI=body mass index, WC=waist circumference, WHtR=waist-to-height ratio.

| N=719 | ESTIMATOR | 95% CI |
|---|---|---|
| BMI [kg/m²] | -0.173 | [-0.401; 0.056] |
| WC [cm] | -1.544 | [-2.448; -0.646] |
| WHtR | -0.014 | [-0.021; -0.007] |

Table 3

URMEL-ICE one-year intervention costs in 2008 Euro (reproduced with permission from Kesztyüs et al. (22)).

| ITEM | QUANTITY | UNIT COSTS | TOTAL COSTS |
|---|---|---|---|
| Teacher time<br>training<br>prepare lessons | 3 times 2 hours, 46 teachers<br>mean 6.57h, 46 teachers | 22.62/h<br>22.62/h | 6,243.12<br>6,836.22 |
| Scientific coordinator | 40% of total working time | Annual salary 30,000.00 | 12,000.00 |
| Work books and copies | 46 classes | 30.00/each | 1,380.00 |
| Postal charges | 6 packages, 46 teachers | 1.45/package | 400.20 |
| Total | | | 26,859.54 |
| Per pupil (1,115) | | | 24.09 |

tivity in children and adolescents (24). The selection is limited to programs aiming at primary schoolchildren and limited to one example from the Australian Assessing Cost-Effectiveness in Obesity (ACE-Obesity) approach (5).

It is obvious, that there are some difficulties, firstly to compare the results of these programs with one another, and secondly to decide whether an intervention is cost-effective or not. The "Fit for Pisa" program costs €236-€619 (2007) per student per year, but there is no threshold for cost-effectiveness (26). The "Walking Bus" intervention costs AUD$760,000 per DALY averted, which is obviously beyond the threshold of three times GDP per capita and therefore is definitely not cost-effective (30). The "Apple" program costs NZ$1,281 (2006) per child for two years, but needs to be converted into Euro for the year 2007 to compare it to the costs of the "Fit for Pisa" intervention (28). Further health economic results of the "Apple" intervention are the costs of NZ$664-$1,708 per kg weight-gain prevented. The "FitKid Project" on the other hand reports costs of US$417 per percent body fat reduction (45). Unfortunately, the percent body fat reduction cannot directly be compared to the kg weight-gain prevented from the "Apple" intervention. The costs per student year of the "FitKid Project" to the amount of US$558-$956, again have to be converted in Euro (2007) or NZ$ (2006) to make comparisons with the "Fit for Pisa" or the "Apple" program. Quite apart from the fact that this would only be comparisons of costs per capita, and therefore not taking into account any effects. The "CATCH" intervention costs US$900-$903 per QALY saved, compared to the value of US$50,000 for a QALY in the US, this program can be considered as cost-effective (3).

For multi-component preventive, or health-promotion interventions, it is difficult to furnish proof of the evidence of a short-term, significant effect on the health-related quality of life. Modelling studies that try to enlarge the time-horizon are always dependent on the quality of their assumptions, and in the worst case this may lead to "garbage in, garbage out", in case of scientifically weak assumptions without sufficient evidence. Therefore, results from modelling studies should always be considered with caution (29). The QALY concept itself is questionable for primary prevention and health promotion, because ›

Table 4

Logistic regression model for the incidence of abdominal obesity in the „Join the healthy Boat" intervention. OR=odds ratio, CI=confidence interval, [a]=multiplied by 10, (Data summarized from Kesztyüs et al. (20)).

| | (N=1,538, R2=0.14) | |
|---|---|---|
| COVARIATES | OR | 95% CI |
| Intervention | 0.48 | [0.25; 0.94] |
| Grade 2 | 0.38 | [0.19; 0.79] |
| Female | 1.19 | [0.62; 2.29] |
| WHtR baseline[a] | 4.34 | [2.39; 7.88] |
| Skipping breakfast | 3.68 | [1.85; 7.33] |

Table 5

"Join the Healthy Boat" one year intervention costs in 2010 Euro. *81 teachers taking part in the outcome-evaluation out of 439 who received vocational training.

| CATEGORY | TOTAL COSTS [€] | WEIGHTED [€] (81/439)* |
|---|---|---|
| Two seminars for consulting teachers | | |
| Personell costs for speakers | 260.00 | 47.97 |
| Rent, subsistence, travel expenses and hotel costs | 9,459.29 | 1,745.34 |
| Materials | 2,011.64 | 371.17 |
| Total | 11,730.93 | 2,164.48 |
| Three vocational trainings for teachers | | |
| Materials | 31,488.61 | 5,809.97 |
| Postal charges | 336.20 | 62.03 |
| Total | 31,824.81 | 5,872.00 |
| Personel costs | | |
| Salary: consulting teachers | 35,500.00 | 6,550.11 |
| Salary: university staff | 118,800.00 | 21,919.82 |
| Total | 154,300.00 | 28,469.93 |
| Total | **197,855.74** | **36,506.41** |
| Per pupil (1,458) | | **25.04** |

the benefits in terms of better health related quality of life as a result of these interventions are almost not immediately perceptible, but only in the future, and this is especially true for interventions in children.

## Cost-Effective Lifestyle Interventions in Schoolchildren

In Germany, two lifestyle interventions in schoolchildren have proved their cost-effectiveness. The first one, "URMEL-ICE" (Ulm Research of Metabolism, Exercise and Lifestyle Intervention in Children) was conducted from 2006-2009 and targeted primary schoolchildren in the second grade. The quality of the URMEL-ICE economic evaluation has been rated as "excellent" in a systematic review of health promotion programs for children and adolescents (25). The second one, "Join the healthy Boat", was an extension and further development of the URMEL-ICE intervention, aimed at schoolchildren in all four grades of primary school. The "Join the healthy Boat" program started in 2009 and has been continuously offered to all primary schools in the state of Baden-Württemberg since then.

## Program Description

Both programs comprise of health promotion, and prevention for primary schoolchildren which is integrated into regular lessons. The intervention materials were developed in cooperation between experienced teachers and scientists from different disciplines, including educationalists, psychologists, nutritionists, pediatricians, sports scientists, sports physicians, epidemiologists and public health specialists. Three crucial risk factors for childhood overweight and obesity were addressed: physical activity, consumption of sweetened beverages, and media use. The intervention consists of 20-28 units for regular teaching time, spread over 36 weeks in one school year, regular activity breaks, six family homework assignments that have to be completed by the children and their parents, and information material for parents. Teachers were trained in three courses to familiarize themselves with the material and the implementation of the intervention.

## Program Evaluation

Both programs were evaluated on their cost-effectiveness in cluster-randomized trials with wait-list control groups. Outcome measures for the effectiveness were waist circumference (WC), waist-to-height ratio (WHtR) and incidence of abdominal obesity (WHtR≥0.5). These measures were chosen with regard to their superiority over measures that rely on body mass index (BMI). Firstly, because BMI is a problematic measure for physical activity interventions (6); secondly because BMI fails to identify obesity in a significant percentage of children (19); thirdly because obesity-related health risks are explained by waist circumference (WC), not BMI (18); and finally in light of the increasing rates of abdominal obesity in children (12, 14). A further advantage of WHtR is the fact that no age- and sex-specific values are needed (42).

The effects for the URMEL-ICE intervention were adjusted in a multi-level regression model (22). Table 2 shows the estimators and the corresponding confidence intervals from the regression models for the respective outcome variable.

To determine cost-effectiveness, the costs for the implementation of the intervention had to be collected in a routine manner. Table 3 shows the costs for the URMEL-ICE intervention.

Eventually, to calculate the incremental cost-effectiveness ratio (ICER), the differences in costs between intervention (I) and control (C) are compared to the differences in effects: ICER: $(C_I\text{-}C_C)/(E_I\text{-}E_C)$=(Differences in costs)/(Differences in effects).

For the waist circumference, this resulted in €11.11 per cm waist gain prevented, for the WHtR the costs were €19.62 per unit (0.01) of WHtR gain prevented.

The second lifestyle intervention, the "Join the healthy Boat" program, was examined on its influence on the incidence of abdominal obesity. After ruling out possible clustering effects, the adjusted odds ratio for the development of abdominal obesity during the intervention period was 0.48, indicating less than half the chance for incidental abdominal obesity for participants in the intervention group (20). Table 4 shows the results from the logistic regression analysis to specify the intervention effect.

Again, the costs for the routine implementation of the program were collected and calculated for the participating teachers and pupils. Table 5 provides an overview on the costs in different categories.

Finally, the costs per case of incidental abdominal obesity averted in the intervention period were calculated. The narrowest view of the participants with complete datasets for the logistic regression analysis resulted in €1,524.92 per case averted. Projecting on all children that were in the intervention classes, and therefore were reached by the intervention, the resulting number is €1,921.39. Table 6 shows details of the calculation of cost per case averted.

Table 6

Model calculations for costs per case of abdominal obesity averted for different ranges of the intervention. IG=intervention group, CG=control group, DS=datasets, CI=confidence intervals, [a]=Incidence IG (n=955): 0.022; 95% CI [0.013; 0.031], [b]=Incidence CG (n=778): 0.035; 95% CI [0.022; 0.048], [c]=see Table 5 (Data summarized from Kesztyüs et al. (20)).

| | CASES EXPECTED | CASES OBSERVED | CASES AVERTED | TOTAL COSTS | COSTS/CASE AVERTED |
|---|---|---|---|---|---|
| **IG only complete DS in logistic Regression (n=847)** | 30[b] | 16 | 14 | 847*€25.04 | €1,514.92 |
| **All pupils in the intervention classes (n=1458)** | 51[b] | 32[a] | 19 | €36,506.41[c] | €1,921.39 |

## Valuation of Cost-Effectiveness

To decide whether these programs are cost-effective, a threshold for cost-effectiveness is indispensable. For this purpose, the parental willingness to pay (WTP) was assessed in the follow-up measurement of the "Join the healthy Boat" outcome evaluation in 2011. A general WTP to reduce the incidence of childhood overweight/obesity by half was declared by 48.8% of the respondents. Of 1, 593 participating parents, 710 (44.6%) stated the amount of their WTP, with a mean value of €23.04/month. Assuming a WTP of zero for those who did not respond, and those who were not willing to pay, results in an overall average WTP of €10.27/month or €123.24/year (21). Comparing the annual WTP to the costs of the "URMEL-ICE" program of €24.09 per child and year, it is obvious that the program costs are far below the parental WTP. The same applies for the "Join the healthy Boat" program, incurring costs of €25.04 per child and year. Hence, both programs can be considered cost-effective.

## Relevance of Abdominal Obesity

Abdominal obesity is a key measure of, and highly important in the context of health, economy and physical activity. Both, abdominal obesity and a lack of physical activity contribute to the development of NCDs, presumably via chronic inflammation (7, 15).

Abdominal obesity is characterized by the increased storage of fatty acids in the subcutaneous and visceral adipose tissue. Adipose tissue is recognized as an endocrine organ with visceral adipose tissue, as a particularly important metabolic tissue, that secretes factors that systemically alter the immunological, metabolic and endocrine milieu. Excess visceral adipose tissue induces a state of chronic systemic inflammation with associated hypertension, dyslipidemia, and insulin resistance summarized as the metabolic syndrome. Furthermore, visceral obesity and associated metabolic disorders are crucially involved in the pathogenesis of certain cancer types (10).

Another mechanism decisive for child development and academic achievement, is the association of abdominal obesity with cognitive function (9, 27, 52).

Physical inactivity and sedentary behavior are both directly related to abdominal obesity and its adverse health effects (16, 23). Another apparent risk factor for the development of abdominal obesity is the consumption of sugar sweetened beverages (SSB) (1). But even without dietary restrictions, exercise can lead to a reduction in total and visceral fat plus an increase in skeletal muscle mass, contrary to the loss of muscle mass as it was observed in the diet alone intervention (23, 37).

## Conclusion

In the light of the growing threat of NCDs to public health and health care costs, evidence based measures to fight the epidemic at its roots are urgently needed. Physical activity promotion interventions in a school setting are an early and promising measure to reduce risks for the development of NCDs. Changes in WC and WHtR as well as the incidence of abdominal obesity are favorable outcome measures, not only because of the easy way of measurement, but much more due to the relevance of abdominal obesity in the development of chronic diseases. School-based interventions with proven cost-effectiveness do exist and should be implemented nationwide.

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**Conflict of Interest**

*The authors have no conflict of interest.*

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