Universitätsklinikum Ulm

Zentrum für Innere Medizin

Sektion für Sport- und Rehabilitationsmedizin

Leiter: Prof. Dr. med. Dr. h.c. Jürgen M. Steinacker

Ökonomische Aspekte der Gesundheitsförderung im Kindesalter

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Romy Lauer

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Amtierender Dekan: Prof. Dr. rer. nat. Thomas Wirth

Erstgutachter: Prof. Dr. med. Dr. h.c. Jürgen M. Steinacker

Zweitgutachter: Priv. Doz. Dr. biol. hum. Markus Kösters

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Abkürzungsverzeichnis

BMI	Body Mass Index
DRKS	Deutsches Register Klinischer Studien
IKER	Inkrementelle Kosten-Effektivitäts-Relation
WHtR	Waist-to-Height-Ratio, Bauchumfang-Körperhöhen-Verhältnis
WTP	Willingness to pay, Zahlungsbereitschaft
WHO	World Health Organisation

1. Einleitung

Übergewicht und Adipositas sind ein verbreitetes Problem, dass zu gravierenden Gesundheitsproblemen führen kann und bereits im Kindesalter beginnt. Weltweit ist etwa jedes fünfte Kind davon betroffen [1], mit steigenden Prävalenzen sowohl gemessen am Body Mass Index (BMI) [1] als auch an der abdominalen Adipositas [2]. Adipositas ist ein Risikofaktor für nicht-übertragbare Krankheiten [3], die zu den weltweit wichtigsten Todesursachen zählen. Übergewicht und Adipositas im Kindesalter sind zudem mit psychischen Problemen wie Angst und Depression [4,5], Stigma [6] und mit geringen akademischen Leistungen [7]) assoziiert. Diese Beeinträchtigungen sind nicht nur für die betroffenen Kinder eine Belastung, sondern können auch eine Herausforderung für die ganze Familie sein.

Betrachtet man die gesellschaftlichen Kosten, entstehen diese durch eine größere Inanspruchnahme von Gesundheitsleistungen [8] und hohen Kosten für eine pharmazeutische und medizinische Versorgung [9]. Körperliche Inaktivität, die mit Übergewicht zusammenhängt, sorgte einer konservativen Schätzung zufolge im Jahr 2013 beispielsweise für weltweite Kosten in Höhe von ca. 53,8 Milliarden Dollar [10].

Da übergewichtige und adipöse Kinder dies auch oft im Erwachsenenalter bleiben [11,12], sind gezielte und früh einsetzende Präventions- und Gesundheitsfördermaßnahmen unerlässlich. Das Setting Schule ist hierbei besonders geeignet, da es alle Kinder gleichermaßen erreicht. Die Weltgesundheitsorganisation (WHO) hat bereits 1995 eine globale Schulgesundheitsinitiative lanciert [13] und ein Jahrzehnt später Maßnahmen als besonders effektiv eingestuft, die mentale Gesundheit, gesunde Ernährung und körperliche Aktivität fördern [14]. Mittlerweile richten sich zahlreiche Interventionen auf die Förderung von körperlicher Aktivität und gesunder Ernährung sowie aufgrund der raschen Ausbreitung von computer- und internetgestützten Medien auf die Reduktion von Medienkonsum und sitzendem Verhalten. Einige der Programme, die oft in Schulen stattfinden, haben Ihre Wirksamkeit aufzeigen können [15], jedoch fehlt meist eine Prüfung auf deren Wirtschaftlichkeit [15–17]. Der großen Anzahl an Interventionen stehen die limitierten finanziellen Ressourcen gegenüber, wodurch eine wohlüberlegte Auswahl von förderungswürdigen Interventionen unerlässlich ist, die eine Kosten-Effektivitätsabschätzung als Auswahlkriterium einbeziehen sollte.

Während Versorgungsforschung immer mehr an Bedeutung gewinnt und z.B. in Deutschland durch den Innovationsfonds gefördert wird, ist Versorgungsforschung im Bereich Gesundheitsförderung bei Grundschulkindern (noch) sehr selten zu finden. Untersuchungen zur Kosten-Effektivität, zu direkten und indirekten Kosten durch z.B. Krankheitstage und

Arztbesuche der Kinder sowie Fehltage der Eltern und Untersuchungen zur elterlichen Zahlungsbereitschaft für die Reduktion von Übergewicht und Adipositas bei Kindern sind rar gesät [15,17–19]. Letztere könnten jedoch als Referenzwert für Kosten-Effektivitätsanalysen von Präventions- und Gesundheitsförderprogrammen im Kindesalter dienen [20].

Die Universität Ulm initiierte im Jahr 2005 das Gesundheitsförderprogramm „Ulm Research on Metabolism, Exercise and Lifestyle Intervention in Children (URMEL-ICE)“, welches sich als wirksam und kosten-effektiv erwies [21]. Darauf aufbauend wurde 2009 das Programm „Komm mit in das gesunde Boot - Grundschule“ landesweit umgesetzt und ab 2010 in der „Baden-Württemberg-Studie“, einer cluster-randomisierten prospektiven Studie, evaluiert. Die Zahlungsbereitschaft der Eltern wurde hierbei bereits im Querschnitt untersucht [22].

2. Zielsetzung der Arbeit

Im Rahmen dieser kumulativen Doktorarbeit sollen ökonomische Aspekte der Gesundheitsförderung im Kindesalter untersucht werden. Hierzu wurden Daten des Baden-Württemberg-weiten schulbasierten Gesundheitsförderprogramms „Komm mit in das gesunde Boot - Grundschule“ untersucht und ausgewertet. Abbildung 1 zeigt die Determinanten der Intervention sowie die gesundheitsökonomischen Parameter. Letztere werden oft in einer als „piggyback evaluation“ bezeichneten Methode betrachtet: Ökonomische Analysen, die quasi „Huckepack“ an eine Effektivitätsanalyse eines Programms gekoppelt sind.

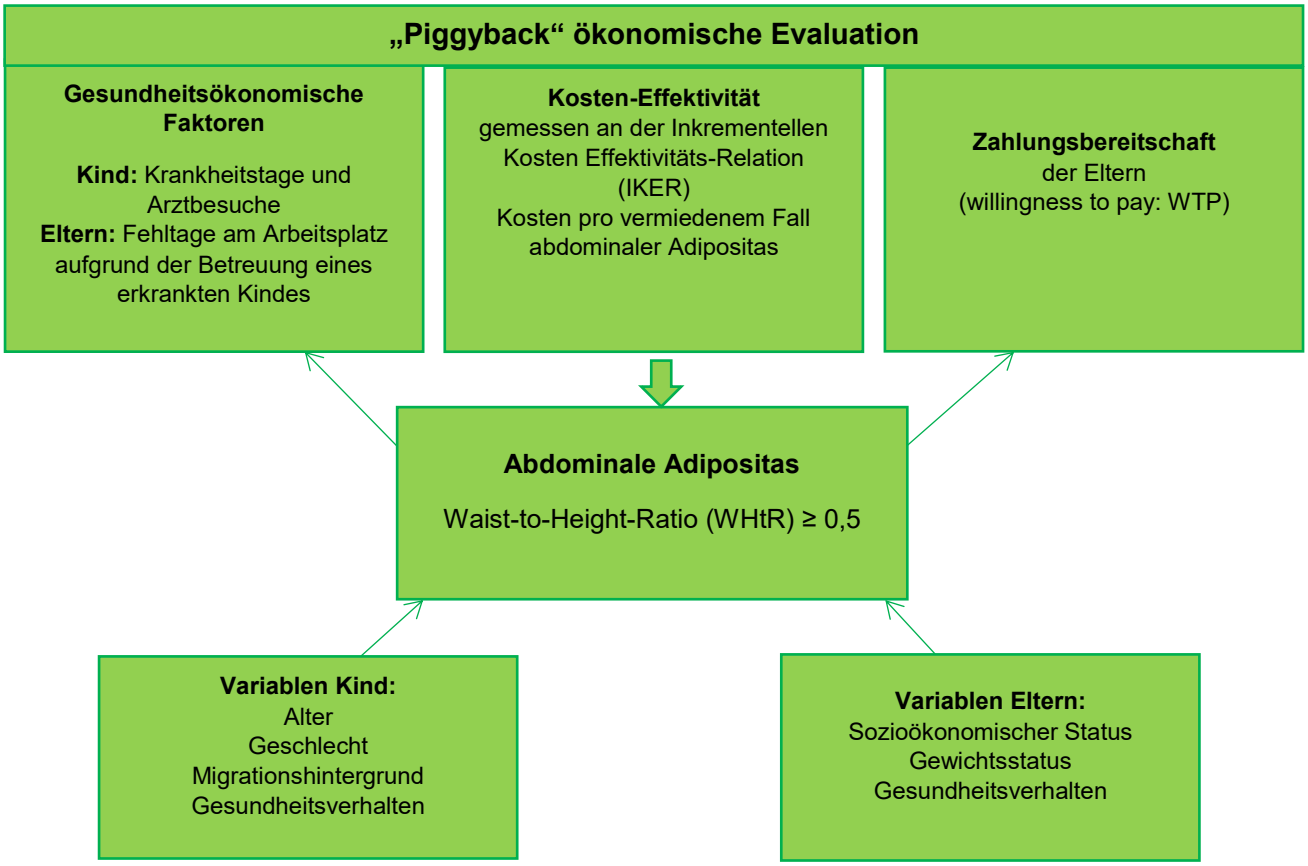

Abbildung 1: Variablen und gesundheitsökonomische Parameter des Gesundheitsförderprogramms „Komm mit in das gesunde Boot - Grundschule“

Drei relativ wenig erforschte, aber sehr relevante Themenbereiche der Versorgungsforschung lagen hierbei im Fokus: Krankheitstage und Arztbesuche der Kinder sowie Fehltage der Eltern aufgrund einer Erkrankung ihres Kindes dienen als Maß für direkte und indirekte Kosten, während die Zahlungsbereitschaft der Eltern für Prävention von

Übergewicht und Adipositas bei Kindern als Referenzwert für die durchgeführte Kosten-Effektivitätsanalyse genutzt werden kann. Die folgenden Fragestellungen werden bearbeitet, um wichtige Informationen zu ökonomischen Aspekten von Gesundheitsförderung im Kindesalter zu liefern:

1. Direkte und indirekte Kosten: Gibt es Interventionseffekte der direkten und indirekten Kostenparameter, genauer gesagt der Krankheitstage und Arztbesuche der Kinder sowie Fehltage von arbeitenden Eltern aufgrund einer Erkrankung ihres Kindes?
2. Kosten-Effektivität: Was kostet die Intervention insgesamt und pro Schüler und Jahr und wie sieht die Inkrementelle Kosten-Effektivitäts-Relation (IKER) für die Kosten pro vermiedenem inzidenten Fall abdominaler Adipositas für verschiedene Dimensionen der von der Intervention erreichten Zielgruppe aus?
3. Elterliche Zahlungsbereitschaft: Wie verändert sich die elterliche generelle Zahlungsbereitschaft sowie deren Höhe für die Prävention von Übergewicht und Adipositas bei Kindern im Längsschnitt und welche möglichen Determinanten gibt es?

3. Methoden

Die untersuchten Daten stammen aus der „Baden-Württemberg-Studie - Grundschule“, die die Wirksamkeit des schulbasierten Gesundheitsförderprogramms „Komm mit in das gesunde Boot - Grundschule“ evaluiert. Das schriftliche Einverständnis des Ministeriums für Kultus, Jugend und Sport des Landes Baden-Württemberg für eine Studie an Schulen des Landes lag vor. Die Prüfung der Ethikkommission der Universität Ulm, die Registrierung der Studie im Deutschen Register Klinischer Studien der Universität Freiburg (DRKS-ID: DRKS00000494) sowie schriftliche Einverständnisse der Eltern liegen vor.

3.1 Gesundheitsförderprojekt „Komm mit in das gesunde Boot - Grundschule“

Das schulbasierte Gesundheitsförderprogramm „Komm mit in das gesunde Boot - Grundschule“ samt aller Materialien wurde von WissenschaftlerInnen der Universität Ulm mithilfe des Intervention Mapping Ansatzes [23] entwickelt und basiert auf der Sozial-Kognitiven Theorie [24] und dem sozialökologischen Modell [25]. Ziel des Programms für Grundschulen ist die Förderung der körperlichen Aktivität und die Reduktion des Konsums gesüßter Getränke und des Medienkonsums der Grundschulkinder sowie die Prävention von Übergewicht und Adipositas.

Die Materialien, die von den LehrerInnen der Jahrgangsstufen 1-4 in Grund- und Sonderschulen in Baden-Württemberg im Regelunterricht eingesetzt werden, orientieren sich am Bildungsplan und beziehen auch die Eltern mit ein. Um eine flächendeckende Verbreitung und Umsetzung des Programms zu gewährleisten, wurde ein sog. Multiplikatorensystem angewendet. Hierbei wurden 1-2 erfahrene LehrerInnen (sog. Multiplikatoren) aus jedem Stadt- und Landkreis durch das wissenschaftliche Team einmalig in die Inhalte des Programms eingearbeitet und werden seither in zwei Schulungen pro Jahr geschult. Diese Multiplikatoren bilden LehrerInnen in ihren Landkreisen in zwei bis drei Fortbildungen aus, die wiederum das Programm in ihrem Unterricht umsetzen.

3.2 „Baden-Württemberg Studie”

Die „Baden-Württemberg Studie“ ist die Outcome Evaluation des Programms „Komm mit in das gesunde Boot - Grundschule“ und wurde als clusterrandomisierte Interventionsstudie mit Warte-Kontrollgruppe im gleichnamigen Bundesland durchgeführt. Zu drei Zeitpunkten wurden Messungen durchgeführt: T1) Baseline Erhebung im Herbst 2010; T2) erste Follow-up Erhebung im Herbst 2011; T3) zweite Follow-up Erhebung im Frühjahr 2013 (Abbildung

2). Die Interventionsgruppe konnte direkt nach T1 das Programm durchführen, während die Kontrollgruppe erst nach T2 damit beginnen durfte. Weitere Informationen zur Studie wurden bereits publiziert [26].

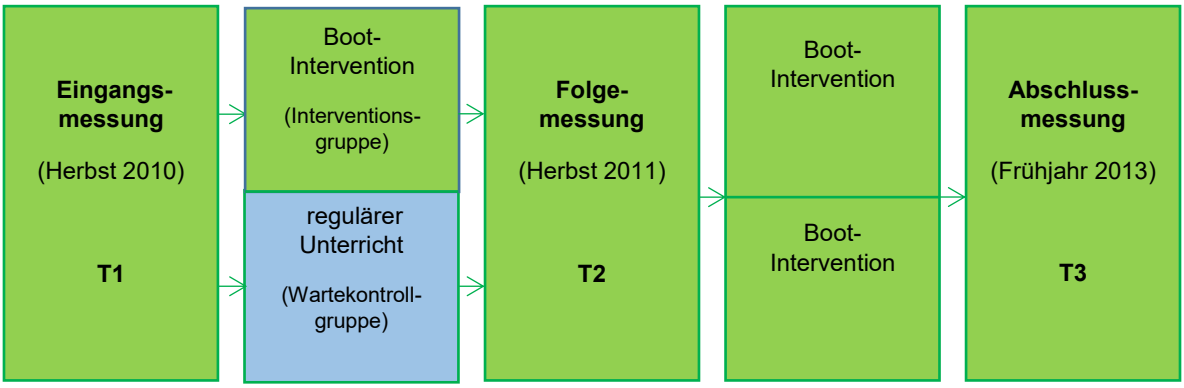

Abbildung 2: Studiendesign der „Baden-Württemberg Studie - Grundschule“

3.3 Datenerhebung

Anthropometrische Messungen der teilnehmenden Kinder wurden von wissenschaftlichen MitarbeiterInnen und geschulten Hilfskräften vor Ort in den Schulen durchgeführt. Eltern machten in Fragebögen Angaben zu verschiedensten Parametern. Für die Gegenüberstellung der Kosten und Effekte wurden detailliert die Kosten der routinemäßigen Durchführung des Gesundheitsförderprogramms erhoben. Für die Beantwortung der Fragestellungen wurden die Messzeitpunkte T1 und T2 bzw. T2 und T3 genutzt, es handelt sich daher um Längsschnittstudien.

Anthropometrie

Anthropometrische Werte der Kinder wurden in Unterwäsche und ohne Schuhe anhand der International Society for the Advancement of Kinanthropometry Standards (ISAK) [27] gemessen. Das Gewicht und die Größe der Kinder wurden mit einer geeichten und kalibrierten Flachwaage bzw. mit einem mobilen Stadiometer gemessen (beide von Seca®, Germany). Der BMI wurde berechnet als Gewicht in Kilogramm geteilt durch die Körpergröße in Meter zum Quadrat. Der BMI der Kinder wurde nach den deutschen alters- und geschlechtsspezifischen Perzentilen bestimmt, wobei das 90. Perzentil als übergewichtig und das 97. Perzentil als adipös eingestuft wurde [28]. Der Bauchumfang wurde in cm mit einem Metallmaßband (Lufkin® Industries Inc., Texas, USA) genau in der Mitte zwischen dem Beckenkamm und dem unteren Rippenbogen gemessen. Die abdominale Adipositas

wurde anhand der Waist-to-Height-Ratio (WHtR) bestimmt und aus dem Quotient des Bauchumfangs und der Körpergröße in cm berechnet, wobei eine WHtR ≥ 0,5 als abdominal übergewichtig definiert wurde [29]. Die von den Eltern bei sich selbst erfassten und im Fragebogen notierten Parameter Gewicht, Körpergröße und Bauchumfang wurden für die Berechnung des BMI und der WHtR genutzt. Ein BMI ≥ 25 wurde nach WHO Standards als übergewichtig und ein BMI ≥ 30 als adipös [30] definiert, während die WHtR ≥ 0,5 wie bei den Kindern als abdominal adipös eingestuft wurde [29].

Elternfragebögen

Eltern machten in einem Fragebogen Angaben zu Soziodemographie, Gesundheitsstatus und Gesundheitsverhalten der Kinder und ihrer selbst und zu ihrer Anthropometrie. Aufgrund der großen Anzahl und Bandbreite der erhobenen Daten wurde eine Auswahl getroffen, die hauptsächlich Variablen beinhaltete, die erwiesenermaßen mit der Entstehung oder dem Vorhandensein von Übergewicht und (abdominaler) Adipositas zusammenhängen, oder bei denen ein Zusammenhang vermutet wird. Des Weiteren wurden einige Kontrollvariablen für die notwendige Adjustierung der statistischen Ergebnisse und somit für die Vermeidung einer möglichen Verzerrung genutzt.

Gesundheitsökonomische Parameter

Der Elternfragebogen erfasste auch Daten zu gesundheitsökonomischen Aspekten. Hierzu zählten die Erkrankungshäufigkeit der Kinder, die Anzahl der Arztbesuche der Kinder und die Fehltage der Eltern am Arbeitsplatz aufgrund der Betreuung eines erkrankten Kindes. Zusätzlich wurde die generelle Zahlungsbereitschaft der Eltern für die Prävention von Übergewicht und Adipositas von Kindern erfragt sowie die Höhe des Betrags, den Eltern dafür bezahlen würden. Die Zahlungsbereitschaft kann mit verschiedenen direkten und indirekten Messmethoden gemessen und den Ergebnissen einer Kosten-Effektivitätsanalyse gegenübergestellt werden [31].

Für die Kosten-Effektivitätsanalyse wurden die Kosten der routinemäßigen Durchführung der Intervention detailliert für ein Jahr erhoben. Hierzu wurde die gesellschaftliche Perspektive eingenommen und dazu die gesamten Kosten erhoben inklusive der Material- und Personalkosten und der Kosten für die Schulungen und Fortbildungen. Anschließend wurden die Kosten pro Kind und die Inkrementelle Kosten-Effektivitäts-Relation (IKER) für die Kalkulation der Kosten pro vermiedenem Fall abdominaler Adipositas berechnet. Die IKER wird definiert als das Verhältnis der Interventionskosten und der Interventionseffekte, wobei

die Kosten bzw. Effekte der Kontrollgruppe von denen der Interventionsgruppe abgezogen werden. Da es sich im untersuchten Fall bei der Vergleichsgruppe um eine Kontrollgruppe ohne alternative Intervention handelte, wurden hierfür keine Kosten erfasst.

3.4 Statistische Analysen

Die jeweiligen Gruppenunterschiede der Baseline Charakteristika wurden in Abhängigkeit von ihrem Skalenniveau und der zugrunde liegenden Verteilung mit Fisher´s Exact Test für kategorische Daten und dem Mann-Whitney U-Test, t-Test oder Welch Test für stetige Daten untersucht. Um mögliche Effekte aufzuzeigen, wurden logistische bzw. lineare Regressionsmodelle berechnet. Das Signifikanzniveau wurde für zweiseitige Tests auf $\alpha < 0{,}05$ festgelegt. Aufgrund von fehlenden Werten kann die Gruppengröße variieren. Das Statistikprogramm IBM SPSS Statistics Release 21.0 (SPSS Inc., Chicago, IL, USA) wurde verwendet.

Aufgrund der Clusterung der Daten in Schulen wurden alle Regressionsanalysen auf einen möglichen Schuleffekt geprüft. Wenn dies der Fall war, wurde ein linear gemischtes bzw. generalisiertes lineares gemischtes Modell berechnet. Hierfür wurde das Programm R Release 3.1.2 bzw. 3.2.3 (http://cran.r-project.org) genutzt.

Weitere Informationen zu den erhobenen Parametern sowie der statistischen Analyse werden im Nachfolgenden für die Publikationen dargestellt.

4. Publikationen

Im Nachfolgenden werden die drei Publikationen im Detail vorgestellt.

4.1 Kesztyüs D, Lauer R, Traub M, Kesztyüs T, Steinacker JM. Effects of statewide health-promotion in primary schools on children's sick days, visits to a physician and parental absence from work: a cluster randomized trial. BMC Public Health 2016;16:1244.

Hintergrund: Fehlzeiten sind positiv mit chronischen Erkrankungen [32] und negativ mit Schulleistungen assoziiert [33]. Arztbesuche der Kinder und Produktivitätsverluste aufgrund der Abwesenheit von Eltern um auf ihr krankes Kind aufzupassen bedeuten höhere Kosten für das Gesundheitssystem und die Volkswirtschaft.

Ziel war es, Interventionseffekte des schulbasierten Gesundheitsförderprogramms „Komm mit in das gesunde Boot - Grundschule" auf die Krankheitstage und Arztbesuche der Kinder sowie Fehltage von arbeitenden Eltern aufgrund einer Erkrankung ihres Kindes zu untersuchen.

Methoden: Longitudinale Unterschiede der Outcome Variablen Krankheitstage und Arztbesuche der Kinder sowie Fehltage der Eltern aufgrund einer Erkrankung ihres Kindes (separat für Mütter und Väter erfasst) wurden zwischen T1 und T2 anhand der Daten von Erst- und Zweitklässlern sowie deren Eltern untersucht. Um mögliche Zusammenhänge und signifikante Unterschiede aufzudecken, wurden lineare und lineare gemischte Modelle berechnet.

Resultate: Die Daten von 1943 Erstklässlern (n=1024, 6,6±0,4 Jahre) und Zweitklässlern (n=919, 7,6±0,4 Jahre) wurden für die Baseline Erhebung genutzt. Nicht adjustierte longitudinale Unterschiede der Mittelwerte zwischen Kindern der Interventions- und der Kontrollgruppe wurden für Krankheitstage der Kinder (-3,2±7,1 vs. -2,3±5,6, p=0,013), und für Fehltage der Mütter (-0,9±2,4 vs. -0,5±2,8, p=0,019) gefunden. Der Effekt für die Krankheitstage der Kinder blieb für Erstklässler signifikant, wenn man für Baseline Werte, Geschlecht und Migrationshintergrund adjustierte (B=-0,83, p=0,003). Nach der Adjustierung für Baseline Werte waren die Fehltage der Mütter allerdings nicht mehr signifikant. Arztbesuche der Kinder und Fehltage der Väter zeigten keine signifikanten longitudinalen Unterschiede.

Diskussion: Es konnte gezeigt werden, dass Erstklässler durch die Intervention circa einen Tag weniger häufig fehlen. Die signifikante Reduktion dieser Krankheitstage kann mit einer

Verbesserung der körperlichen Aktivität, der Ernährung und des Medienkonsums [34], aber auch mit einer Reduktion der inzidentellen abdominalen Adipositas [35] zusammenhängen, wobei letztere positiv mit Krankheitstagen korreliert [36].

4.2 Kesztyüs D, Lauer R, Kesztyüs T, Kilian R, Steinacker JM. Costs and Effects of a State-Wide Health Promotion Program in Primary Schools in Germany - The Baden-Württemberg Study: A Cluster-Randomized, Controlled Trial. PLoS ONE 2017, 12(2):e0172332.

Hintergrund: Einige der nicht-übertragbaren Krankheiten sind mit dem metabolischen Syndrom assoziiert, bei dem abdominale Adipositas eine der wichtigsten Komponenten ist [37]. Es gibt sehr wenige Studien, die eine ökonomische Evaluation einer Gesundheitsintervention durchführen [15,17,19].

Ziel war es, die Kosten-Effektivität der bundesweiten Implementierung des Gesundheitsförderprogramms „Komm mit in das gesunde Boot - Grundschule“ in Baden-Württemberg zu evaluieren.

Methoden: Anthropometrische Daten von 1733 Kindern (7,1±0,6 Jahre) wurden für T1 und T2 ausgewertet. Die Inzidenz für abdominale Adipositas, definiert als WHtR ≥ 0,5, wurde bestimmt. Lineare gemischte Modelle wurden für die Adjustierung für Baseline Werte angewandt. Die Kosten für das Projekt wurden sehr detailliert erfasst und aufgelistet. Aus der gesellschaftlichen Perspektive wurden die Gesamtkosten, Kosten pro Schüler und die inkrementelle Kosten-Effektivitäts-Relation (IKER) für die Kosten pro vermiedenem inzidenten Fall abdominaler Adipositas für verschiedene Dimensionen der von der Intervention erreichten Zielgruppe berechnet.

Resultate: Für die Inzidenz von abdominaler Adipositas liegen nach der Adjustierung für Klassenstufe, Geschlecht, Baseline WHtR Werte und das Frühstücksverhalten niedrigere Chancen für die Interventionsgruppe vor (Odds Ratio=0,48, 95% Konfidenzinterval [0,25; 0,94]). Die Interventionskosten pro Kind pro Jahr betragen 25,04 €. Die Kosten pro vermiedenem inzidenten Fall abdominaler Adipositas variieren zwischen 1514,92 € für die Interventionsgruppe bei Follow-up mit kompletten Datensätzen für die Regressionsanalyse (n=847), 1917,35 € für die Interventionsgruppe bei Baseline (n=1072), 1921,39 € für alle SchülerInnen der Interventionsklassen (n=1458), 1926,15 € für alle voraussichtlich bis zum Schuljahr 2013/14 erreichten SchülerInnen (n=40000) und 1992,77 € für die Interventionsgruppe bei Follow-up (n=955).

Diskussion: Diese Studie zeigt eine signifikante Reduktion der inzidenten abdominalen Adipositas durch die Intervention. Eine Einordnung der Ergebnisse ist aufgrund der wenigen Vergleichsstudien mit zudem häufig unterschiedlichen Outcome Parametern oder unterschiedlichen Schulsystemen schwierig. Jedoch scheinen die Kosten deutlich geringer als die hohen Folgekosten von Adipositas.

4.3 Lauer R, Traub M, Hansen S, Kilian R, Steinacker JM, Kesztyüs D. Longitudinal changes and determinants of parental willingness to pay for the prevention of childhood overweight and obesity. Health Economics Review 2020, 10:15.

Hintergrund: Die Forschung zur Zahlungsbereitschaft (willingness to pay, WTP) zur Gesundheitsförderung und insbesondere zur Reduzierung von Übergewicht und Adipositas bei Kindern ist rar. Kesztyüs et al. haben bereits eine Querschnittsuntersuchung der Baden-Württemberg-Studie durchgeführt, bei der insbesondere Eltern übergewichtiger und fettleibiger Kinder deutlich häufiger zahlungsbereit waren [22].

Ziel war es, die elterliche Zahlungsbereitschaft für Prävention von Übergewicht und Adipositas bei Kindern im Längsschnitt zu untersuchen und mögliche Determinanten zu ermitteln.

Methoden: Daten der beiden Follow-up Erhebungen T2 und T3 wurden verwendet. Im Fragebogen wurden Fragen zur generellen Zahlungsbereitschaft für eine Halbierung der Inzidenz von Übergewicht und Adipositas bei Kindern, sowie bei positiver Antwort nach der Höhe des Betrags pro Monat gestellt. Längsschnittunterschiede wurden mit dem McNemar Test für die generelle WTP und dem Wilcoxon signed-rank Test für die Höhe der WTP ermittelt. Um Determinanten zu identifizieren, wurden Regressionsanalysen durchgeführt.

Resultate: Für die generelle WTP konnte eine signifikante Reduktion von 48,9% auf 35,8% ($p<0.001$, $n=760$) verzeichnet werden. Eltern mit einem tertiären Bildungsniveau, einem höheren Einkommen und einer positiven generellen WTP zu T2 sowie Familien von abdominal-adipösen Kindern waren signifikante Prädiktoren für die generelle WTP zu T3 ($n=561$). Die Höhe der elterlichen Zahlungsbereitschaft zu T3 lag im Median bei 20,00 € (Mittelwert=27.96 € ± 26.90, $n=274$) bzw. bei 0 € (Mittelwert=8,45 €, sd=19.58 €, $n=906$), wenn man für die nicht zahlungsbereiten Eltern und diejenigen mit fehlenden Werten eine Zahlungsbereitschaft von 0 € annimmt. Was die Höhe der WTP zu T3 betrifft, war die WTP zu T2 der einzige signifikante Prediktor ($p=0.000$, $n=181$).

Diskussion: Die größere Zahlungsbereitschaft der von Übergewicht und Adipositas betroffenen Familien sowie der Familien mit einem höheren sozioökonomischen Status spiegelt das Bewusstsein des Problems und die Notwendigkeit zur Handlung wieder. Die Kosten des Programms liegen deutlich unter der gemessenen Zahlungsbereitschaft.

5. Diskussion und Ausblick

Die vorliegende Untersuchung der ökonomischen Aspekte eines Gesundheitsförderprogramms für Grundschulkinder ist weltweit eine der wenigen ihrer Art und in Deutschland einzigartig. Es konnte gezeigt werden, dass die Intervention „Komm mit in das gesunde Boot - Grundschule“ die Krankheitstage der Erstklässler senkt und die abdominale Adipositas der untersuchten Kinder reduziert. Die individuellen Effekte, die vielleicht auf den ersten Blick als gering erscheinen, addieren sich zu einem größeren Effekt für das Gesamtkollektiv in der landesweiten Implementierung des Programms auf. Eine Einordnung der Ergebnisse der Kosten-Effektivität ist aufgrund der wenigen vergleichbaren Studien jedoch schwierig [17,38]. Häufig werden Modelling Studien anstatt primärer Daten untersucht oder BMI und nicht WHtR als Outcome Variable verwendet. Die wenigen bekannten gesundheitsökonomischen Evaluationen von Studien, die jedoch unterschiedliche Interventionen und Schulsysteme beinhalten und daher schwer vergleichbar sind, weisen Beträge im dreistelligen Bereich für die Intervention pro Kind pro Jahr auf [39-42]. Die Kosten der vorliegenden Boot-Intervention mit 25,04 € pro Kind pro Jahr liegen daher deutlich unter diesen Werten und auch deutlich unter der erfassten Zahlungsbereitschaft der Eltern für die Prävention von Übergewicht und Adipositas bei Kindern in Höhe von 101,40 € pro Jahr. Auch wenn die WTP im Laufe der Zeit sinkt, liegt sie immer noch deutlich über dem Wert von $46,41 aus der einzig bekannten vergleichbaren Studie aus den USA [31]. Die WTP kann als Referenzwert für Kosten-Effektivitätsanalysen und somit als Alternative zu QALYs (quality adjusted life years), die im Bereich Prävention schwierig anzuwenden sind, genutzt werden. Die Kosten pro vermiedenem inzidenten Fall abdominaler Adipositas der vorliegenden Untersuchung betragen für die verschiedenen untersuchten Gruppen zwischen 1515 € und 1993 €. Setzt man diese mit den geschätzten direkten und indirekten Kosten von Übergewicht und Adipositas in Höhe von insgesamt 25,7 Mrd. € für 2020 in Relation [43], so wäre diese Investition sinnvoll.

5.1 Relevanz für die Prävention

Interventionen zur Gesundheitsförderung und zur Prävention von Übergewicht und Adipositas im Kindesalter sollten neben der Evidenz für die Effektivität auch die Evidenz für eine Kosten-basierte Effektivität aufzeigen. Bei den limitierten finanziellen Ressourcen und der Vielzahl von bestehenden Interventionen kann eine ökonomische Analyse politische Entscheidungsträger und Geldgeber bei der Auswahl von förderwürdigen Interventionen unterstützen. Häufig sind gesundheitsökonomische Evaluationen jedoch nicht vorhanden [15-17]. Daher ist die vorliegende Untersuchung von großer Relevanz und ist ein Schritt in

die richtige Richtung. Um die ermittelten Ergebnisse besser vergleichen und einordnen zu können, sollten andere WissenschaftlerInnen ökonomische Analysen ihrer Interventionen durchführen. Zu empfehlen ist, diese von Beginn an in die Planung der Studie aufzunehmen. Zudem ist die Wirksamkeit einer gesundheitsfördernden Intervention in einem kurzen Zeitraum schwer zu ermitteln, wodurch längere Untersuchungszeiträume notwendig sind.

Da abdominale Adipositas mit nicht-übertragbaren Krankheiten assoziiert wird und ihre Inzidenz durch die Intervention reduziert werden konnte, ist WHtR als Outcome Variable die beste Wahl. Die Vielzahl der in der Literatur genannten Studien und Interventionen nutzen allerdings den BMI. Der BMI unterscheidet jedoch nicht zwischen Fett- und Muskelmasse, während die WHtR die abdominale Fettverteilung berücksichtigt. Treibt man also mehr Sport und baut dadurch Muskelmasse auf und Fettmasse ab, so wird sich das nicht oder sogar negativ auf den BMI niederschlagen, da Muskeln bei gleichem Volumen aufgrund ihrer höheren Dichte mehr als Fett wiegen. Abdominale Adipositas ist stark mit dem metabolischen Syndrom assoziiert [44], das der größte Risikofaktor für kardiometabole Krankheiten ist, die wiederum die Haupttodesursachen darstellen.

Übergewichte Kinder bleiben oft auch im Erwachsenenalter übergewichtig [12,45]. Daher sollte die Prävention von Übergewicht und Adipositas so früh wie möglich ansetzen. Die steigenden Zahlen von abdominaler Adipositas bei Kindern unterstützen dies [2,46]. Die Implementierung eines Gesundheitsförderprogramms im Setting Schule ist somit eine gute Wahl, zumal man dort alle Kinder erreicht. Dabei ist die Einbeziehung der Eltern ratsam, da Eltern häufig als Vorbilder für ihre Kinder dienen. Eltern können zudem auch von den Präventionsmaßnahmen profitieren, was angesichts der hohen Prävalenz von abdominaler Adipositas der untersuchten Eltern auch sinnvoll scheint. In der Schule kann eine Intervention mit wenigen einfachen Mitteln umgesetzt werden. Integriert man Elemente der Intervention in die Ausbildung der LehrerInnen oder integriert man das Programm in das Curriculum, so können die Kosten für die Intervention noch einmal reduziert werden. Zeitgleich bietet diese Einbettung eine Entlastung der Lehrkörper. Um die Intervention in einem noch früheren Entwicklungsstadium von Kindern anzuwenden und somit die Chancen auf eine langfristige Verhaltensänderung zu erhöhen, wurde das Programm „Komm mit in das gesunde Boot - Grundschule“ angepasst und im Jahr 2016 auch im Kindergarten implementiert.

Jeder Bürger und jede Bürgerin sollten gleichermaßen Zugang zu Prävention und Gesundheitsförderung haben. Sie sind wichtige Maßnahmen, wenn es um die Bekämpfung von Krankheiten geht. Daher sollten politische Entscheidungsträger dem Aufruf der WHO mit ihrem sektorübergreifenden Konzept „health in all policies“ folgen und stets das Thema Gesundheit bei Entscheidungen und in Gesetzen berücksichtigen [47].

6. Zusammenfassung

Hintergrund: Abdominale Adipositas ist ein Risikofaktor für nicht-übertragbare Krankheiten, die weltweit zu den wichtigsten Todesursachen zählen. Übergewicht und Adipositas im Kindesalter manifestieren sich häufig im Erwachsenenalter und sind neben körperlichen und psychischen Problemen auch mit hohen Kosten verbunden. Daher setzen zahlreiche Gesundheitsfördermaßnahmen bereits im Setting Schule an. Ihnen fehlt jedoch meist die Prüfung ihrer Wirtschaftlichkeit, die einen wesentlichen Beitrag zur Selektion von förderungswürdigen Interventionen leisten würde. Versorgungsforschung im Bereich Gesundheitsförderung bei Grundschulkindern wird (noch) sehr selten durchgeführt.

Ziel: Untersuchung der Interventionseffekte des schulbasierten Gesundheitsförderprogramms „Komm mit in das gesunde Boot - Grundschule“ in Baden-Württemberg auf die abdominale Adipositas und die Krankheitstage und Arztbesuche der Kinder sowie Fehltage von arbeitenden Eltern aufgrund einer Erkrankung ihres Kindes. Kosten-Effektivitäts-Analyse des Programms sowie die Erfassung der elterlichen Zahlungsbereitschaft (willingness to pay: WTP) für eine Halbierung der Inzidenz von Übergewicht und Adipositas bei Kindern, die der Kosten-Effektivität als Referenzwert dienen kann.

Methoden: Anthropometrische Daten der Kinder wurden durch geschultes Personal erfasst. Ihr Gewichtsstatus wurde anhand von alters- und geschlechtsspezifischen Body Mass Index (BMI) Perzentilen bzw. einer abdominalen Adipositas mit einer Waist-to-Height-Ratio (WHtR) ≥ 0,5 ermittelt. Eltern machten in Fragebögen Angaben zu Parametern wie z.B. Gesundheitsverhalten, ihrer Anthropometrie, Krankheitstagen und Arztbesuchen ihrer Kinder sowie ihren Fehltagen um auf ein krankes Kind aufzupassen, der generellen WTP sowie bei positiver Antwort die Höhe des Betrages pro Monat, den sie dafür bezahlen würden. Für die Kosten-Effektivitäts-Analyse wurden die Kosten der routinemäßigen Durchführung des Gesundheitsförderprogramms detailliert erhoben. Anschließend wurden die Kosten pro Kind pro Jahr und die inkrementelle Kosten-Effektivitäts-Relation (IKER) für die Kalkulation der Kosten pro vermiedenem inzidenten Fall abdominaler Adipositas berechnet. Gruppenunterschiede wurden untersucht und Regressionsanalysen durchgeführt. Es handelt sich um Längsschnittstudien für die Messzeitpunkte T1 und T2 bzw. T2 und T3. Die Anzahl der untersuchten Personen liegen für die verschiedenen Untersuchungen und Zeitpunkte zwischen 181 und 1943.

Resultate: Signifikante Unterschiede zwischen der Interventions- und der Kontrollgruppe wurden für Krankheitstage der Erstklässler gefunden, wenn man für Baseline Werte, Geschlecht und Migrationshintergrund adjustierte (B=-0,83, p=0,003). Arztbesuche der

Kinder und Fehltage der Väter zeigten keine signifikanten longitudinalen Unterschiede. Die Fehltage der Mütter zeigten zunächst signifikante Unterschiede, die aber nach der Adjustierung für Baseline Werte nicht mehr signifikant waren.

Die Interventionsgruppe zeigt niedrigere Chancen für die Inzidenz von abdominaler Adipositas nach der Adjustierung für Klassenstufe, Geschlecht, Baseline WHtR Werte und das Frühstücksverhalten (Odds Ratio=0,48, 95% Konfidenzinterval [0,25; 0,94]). Die Interventionskosten pro Kind pro Jahr liegen bei 25,04 €. Die Kosten pro vermiedenem inzidenten Fall abdominaler Adipositas variieren zwischen 1514,92 € und 1992,77 € für die verschiedenen untersuchten Gruppen.

Familien von zentral adipösen Kindern sowie Eltern mit einem tertiären Bildungsniveau, einem höheren Einkommen und einer positiven generellen WTP zu T2 waren signifikante Prädiktoren für die generelle WTP zu T3 (n=561). Bei Annahme einer Zahlungsbereitschaft von €0 für diejenigen Eltern, die nicht zahlungsbereit waren oder keine Angaben zu dieser Frage machten, lag die allgemeine Zahlungsbereitschaft im Median bei 0 € (Mittelwert=8,45 €, sd=19,58 €, n=906). Für die Höhe der WTP zu T3 war die WTP zu T2 der einzige signifikante Prediktor (p=0,000, n=181).

Diskussion: Diese Studie zur gesundheitsökonomischen Evaluation eines Gesundheitsförderprogramms für Kinder ist weltweit eine der wenigen ihrer Art und in Deutschland einzigartig. Sie zeigt positive Effekte eines bundesweiten schulbasierten Gesundheitsförderprogramms auf die inzidente abdominale Adipositas und die Krankheitstage von Erstklässlern zu einem bezahlbaren Preis und mit bestätigter Kosten-Effektivität. Die WTP liegt deutlich über den Kosten der Intervention. Die Prävention von abdominaler Adipositas sollte so früh wie möglich, also im Setting Kindergarten oder Schule, ansetzen. Die Resultate der vorliegenden Studie sollen politische Entscheidungsträger in ihren allokativen Entscheidungen unterstützen und somit zu dem Aufruf der WHO nach „health in all policies“ beitragen.

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8. Anhang

8.1 Kesztyüs D, Lauer R, Traub M, Kesztyüs T, Steinacker JM. Effects of statewide health-promotion in primary schools on children's sick days, visits to a physician and parental absence from work: a cluster randomized trial. BMC Public Health 2016;16:1244. DOI 10.1186/s12889-016-3903-2.

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Leistung	**Eigenanteil**	**Anteil der anderen Autoren**	**Spezifizierung des Eigenanteils**
Datenanalyse	20%	80%	Durchführung statistischer Analysen
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RESEARCH ARTICLE Open Access

Effects of statewide health promotion in primary schools on children's sick days, visits to a physician and parental absence from work: a cluster-randomized trial

Dorothea Kesztyüs[1,2*], Romy Lauer[1], Meike Traub[1], Tibor Kesztyüs[3] and Jürgen Michael Steinacker[1]

Abstract

Background: Based on the World Health Organization's global school health initiative we investigate intervention effects of statewide health promotion in schools on the numbers of children's sick days and visits to a physician, and parental days off work due to child illness.

Methods: Cluster-randomized trial with 1-year follow-up in primary schools in the state of Baden-Württemberg, Germany. Anthropometric measurements of first and second grade school children were taken by trained staff. Parents filled in questionnaires for information about socio-demographics, health-related variables, numbers of children's sick days, visits to a physician, and days parents had to stay off work to care for a sick child. Longitudinal differences in the outcome variables were calculated between baseline and follow-up. Intraclass correlation coefficients were determined to quantify a possible clustering of data in schools. Accordingly, linear models and linear mixed models were applied to identify relationships and ascertain significances.

Results: Data from 1943 children (1st grade $n = 1024$, 6.6 ± 0.4 years old; 2nd grade $n = 919$, 7.6 ± 0.4 years old) were available at baseline. Unadjusted differences regarding both grades were found between mean longitudinal changes in intervention and control group in children's sick days (-3.2 ± 7.1 vs. -2.3 ± 5.6, $p = 0.013$), and maternal days off work (-0.9 ± 2.4 vs. -0.5 ± 2.8, $p = 0.019$). The intervention effect on sick days was adjusted in a linear regression for baseline values, gender and migration background and confirmed for first grade children ($B = -0.83$, $p = 0.003$). The intervention effect on maternal days off work lost its significance after adjusting for baseline values. No significant differences were detected in the numbers of children's visits to a physician and paternal days off work.

Conclusions: School-based health promotion slightly reduces sick days in first grade children. Subsequently, parents may not need to stay off work themselves. Small individual effects add up to larger benefits in a statewide implementation of health promotion. Additionally, health promotion may also positively contribute to school success.

Trial Registration: The study was registered on the German Clinical Trials Register (DRKS), Freiburg University, Germany, under the DRKS-ID: DRKS00000494. Registered: 25 August 2010.

Keywords: Sick leave, Child, Schools, Health promotion, Physicians, Utilization, Parents

* Correspondence: dorothea.kesztyues@uni-ulm.de
[1]Division of Sport and Rehabilitation Medicine, Ulm University Medical Center, 89075 Ulm, Germany
[2]Ulm University, Institute of General Medicine, Helmholtzstraße 20, D-89081 Ulm, Germany
Full list of author information is available at the end of the article

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Background

In 1995 the World Health Organisation (WHO) launched the global school health initiative to mobilise and strengthen health promotion and education activities at the local, national, regional and global levels [1]. In their subsequent report on the effectiveness of health promotion in schools in 2006, the WHO identified programmes that promote mental health, healthy eating, and physical activity as being amongst the most effective [2]. They detected that most interventions used classroom-only approaches, and some combined a curriculum approach with environmental changes or family involvement [2]. Combined approaches were more likely to be successful, but many interventions appeared to be ineffective [2]. None of the reviews included in the WHO report provided information on the costs, or cost-effectiveness, of health promotion programmes in schools [2]. However, due to a large amount of existing interventions but limited (financial) resources, cost-effectiveness analyses are essential. For such analyses, direct and indirect costs have to be assessed, and the numbers of visits to a physician or productivity losses due to parental absence from work because they have to care for a sick child are important parts of it.

Only recently, we determined the cost-effectiveness of school-based health promotion in terms of averted cases of incidental abdominal obesity as a result of the Baden-Württemberg Study (unpublished data). A cross-sectional analysis of the baseline data of this study also showed that abdominal obesity in primary schoolchildren was associated with higher rates of children's sick days and more visits to a physician [3]. We use the term sick days for the findings, because absenteeism may have a broader meaning beyond sickness; even though absenteeism and sick leave in the context of school children is used interchangeably by many authors. While school absenteeism has been studied elsewhere from different perspectives [4], information about health-related absenteeism in primary school children is limited. Some authors found associations of body mass index and obesity with school absenteeism, but results are not consistent [5–10]. In a Dutch population sample of 3960 8-year-old children, obesity was associated with significantly more school absenteeism [5]. In contrast, data from 920 fourth grade children in the United States (US) did not show a significant relationship between the number of school days absent for each child and the BMI percentile category [6]. Another study from the US examined more than 165,000 students in grades 1–12 and found only weak associations between obesity and increased school absences [7]. A national survey in the US of 3470 adolescents reported overweight and obese pupils aged 12–17 years of having 36 and 37% more sick days, respectively, than their normal-weight peers [8]. Among 1387 US children (6–11 years) and 2185 adolescents (12–18 years) a relationship between severe absenteeism and weight status was found only in children but not adolescents [9]. Overweight children were significantly more absent than their normal-weight peers in a US study of 1069 forth to sixth graders [10].

Chronic health conditions like asthma, diabetes or attention deficit hyperactivity disorder (ADHD) lead to higher rates of school absenteeism [11]. The association between children's health and performance in school is undisputable and school absenteeism poses a threat to academic achievement [6].

Additionally, visits to a physician, and productivity losses due to parental absence from the workplace to care for a sick child, mean higher costs for health services and national economies. The aim of this study is to investigate intervention effects of the school-based health promotion program "Join the Healthy Boat" on parameters of direct and indirect medical costs, namely the number of days children missed school because they were sick, their visits to a physician and the number of days a working parent had to stay at home to care for a sick child.

Methods

Study description

As the outcome evaluation of the school-based health promotion program, "Join the Healthy Boat", the Baden-Württemberg Study (BW Study) was conducted all over the state of Baden-Württemberg in southern Germany. The cluster-randomized prospective trial included an intervention group and a wait-list control group. The participating primary schools were used as units for the randomization process. According to the number of classes and grades, six different school types were identified and used as strata for randomization [12]. Randomization was performed on 164 teachers in 91 schools, and resulted in 45 schools in the intervention group and 46 schools in the control group.

The study period covered the academic year 2010/11. Written informed consent was obtained from the parents. The study was registered on the German Clinical Trials Register (DRKS), Freiburg University, Germany, under the DRKS-ID: DRKS00000494. Detailed information on the study protocol has already been published elsewhere [12].

Intervention

Based on the social cognitive theory [13] and the socio-ecological model [14], scientists from several disciplines and dedicated practitioners, developed the materials for a health promotion program for all four grades of primary school (age group 6–10), following the intervention mapping approach [15]. The "Join the Healthy Boat" program provides teachers in primary school with various materials to integrate into the regular curriculum without the need for additional lessons. Materials include suggestions for

classroom and homework activities, active breaks, and material for parental involvement. The program aims at a reduction of screen media use and intake of sugar sweetened beverages on the one hand, and at an increase in physical activity on the other hand. Significant results were found for subgroups of the intervention group for screen media use and tendencies but no significant differences for physical activity and the consumption of sugar sweetened beverages [16]. To ensure a state-wide implementation of the program, 32 experienced teachers from all over Baden-Württemberg were trained in two seminars in the concept and materials ("train-the-trainer"). In turn, they trained teachers in their region ("peer-to-peer") in three vocational training sessions, to secure an appropriate application of the program in their classes.

Participants

All pupils within first and second grade classes of teachers who registered for the training on the program in the academic year 2010/11 were eligible for participation. Parents of 1968 pupils gave their written informed consent. Figure 1 shows a flow chart with the respective available numbers of pupils and datasets at the different stages of the study. Data for baseline characteristics were available for 1943 pupils. Datasets with longitudinal information about any of the outcome variables sick days of children, visits to a physician and parental days off work were available for 1379 children (71%).

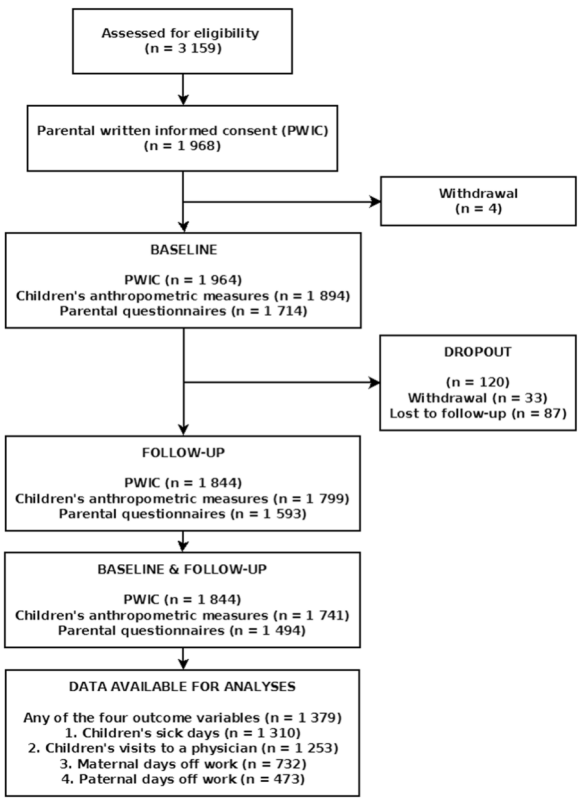

Fig. 1 Flowchart of participants/datasets in the BW Study 2010–2011. Number of respective written informed consents and available data sets from anthropometric measurements and parental questionnaires at several stages of the outcome evaluation process

Data collection

Baseline data collection was conducted at the beginning of the academic year 2010/11, follow-up measurements took place after a one year intervention period in fall 2011. Four teams of scientific researchers and specially trained students visited each participating class in schools all over Baden-Württemberg, and among others carried out anthropometric measurements and fitness testing of children. Parental questionnaires were handed out by teachers and returned to the data centre.

Anthropometrics and fitness testing

The weight and height of children were taken by trained staff according to the International Society for the Advancement of Kinanthropometry (ISAK) standards [17]. Waist circumference (WC) was measured midway between children's ileac crest and lower costal arch to the nearest 0.1 cm. Body Mass Index (BMI) was calculated through dividing weight in kilogram by height in square meter (kg/m^2), and was converted to BMI percentiles (BMIPERC) using German reference data for children [18]. Excess weight and obesity were accordingly defined at or above the 90th and 97th age- and gender-adjusted percentile for children, respectively. Waist-to-height ratio (WHtR) was calculated as the ratio of WC and height, each of them in centimetres. Abdominal obesity was defined as a WHtR ≥ 0.5 following the recommendation of McCarthy and Ashwell [19]. A six minute run test was conducted and used as a proxy for cardiorespiratory fitness [20].

Parental BMI and WHtR were calculated according to self-reported weight, height and WC in the questionnaires, and categorized as overweight (BMI ≥ 25), obese (BMI ≥ 30), and abdominally obese (WHtR ≥ 0.5).

Questionnaires and derived variables

Parents were asked to recall the sick days of their children in the last year of school or kindergarten and their children's numbers of visits to a physician during this period (see Table 1). They gave information about their employment status and their weekly working hours, the monthly household income and the number of days they could not go to work because they had to care for their sick child. Furthermore, both parents gave information on their educational level. They were asked to report their height, weight and WC, and to state their current smoker status. Additionally, single parenthood was assessed.

Table 1 Items in the parental questionnaires for the outcome variables in the BW Study 2010

Outcome variable	Question	Response options (free text)
Child's sick days	On how many days during the last year of school or kindergarten was your child unable to go to school/kindergarten because they were sick?	Number of days
Visits to a physician	How often during the last year of school or kindergarten did you have to visit a physician because your child was sick?	Number of visits to a physician
Days off work mother/father	If you are employed: On how many days during the last year of school or kindergarten did you have to stay off work because your child was sick?	Father: number of days Mother: number of days

A migration background of the child was assumed if at least one parent was born abroad or at least one parent mainly spoke a foreign language during the child's first years of life. As parameters of children's health behaviour, their daily time of outdoor play, the number of days per week they met the WHO guideline of moderate to vigorous physical activity (MVPA) of more than 60 min per day [21], their amount of screen media consumption, their consumption of sugar sweetened beverages, and their breakfast habits were assessed.

Family educational level was ranked in accordance with the CASMIN classification system as the highest level of two parents or the level of a single parent [22]. It was dichotomized for analysis into tertiary level, versus primary and secondary level. Monthly household income was grouped into a low (< €1750) and a high (≥ €1750) category. Outdoor playing was dichotomized at above 60 min/day. Reaching the WHO Guideline for MVPA on four days and more a week was compared to reaching it on three days or less. The use of screen media was divided into more than 60 min/day or less, and the consumption of sugar sweetened beverages into more than one time per week or less. Having breakfast was divided into "never", and "rarely" vs. "often", and "every day".

Losses to follow-up, missing data

Losses to follow-up and missing data are common problems in observational trials and may bias the results [23]. Therefore, baseline differences between participants who took part in both measurements and those who were lost to follow-up or had missing outcome variables were examined with the appropriate statistical tests as described below.

Statistical analysis

Differences between groups were tested according to the scale level and the underlying distribution and variance of the respective variable with Fisher's exact test for categorical data, the Mann–Whitney *U*-test, *t*-test or Welch test for continuous data. Significance level was set to $\alpha < .05$ for two-sided tests. Sample sizes in the analyses differ because of missing data.

Intraclass correlation coefficients (ICC) were calculated for all outcome variables to quantify a possible clustering of data in schools. Intervention effects on the outcome variables were examined in linear regression models or linear mixed models, the latter with respect to a clustering effect. All variables from Table 2, except for the four outcome variables themselves, were considered as possible influential factors on the outcome variables and therefore included in the process of stepwise linear regression analyses. Baseline-differences were tested for their influence on the outcome in regression analyses, and all reported results from regression analyses were adjusted for the baseline values of the outcome. Descriptive and bivariate statistics were conducted with IBM SPSS Release 21.0 for Windows (SPSS Inc, Chicago, IL, USA). Linear regression models as well as linear mixed models were calculated with the statistical software package R Release 3.1.2 for Windows (http://cran.r-project.org).

Results

Baseline characteristics

Baseline characteristics for both groups are displayed in Table 2. Differences between intervention and control group were found in the number of children with a migration background, which was significantly higher in the intervention group. Both parents of children in the intervention group had more days off work to care for a sick child than those in the control groups. Furthermore, children in the intervention group played outside less often and reached a slightly lower distance in the six minute run test.

Intervention effects

Data for the longitudinal changes in the outcome variables are shown in Table 3. In total, a decrease appeared in all four variables over the study period of one year. Significant differences occurred in the number of days children missed at school because of sickness and in the number of maternal days off work in favour of the intervention group. Figure 2 visualises these changes.

Children in the intervention group had a significantly higher reduction in sick days. This effect remains stable for children in grade 1 after adjustment for sex, migration

Table 2 Baseline characteristics of participants in the BW Study 2010

	Missing Values	Intervention (*n* = 1072)	Control (*n* = 871)	Total (*n* = 1943)
Boys, n (%)		536 (50.0)	459 (52.7)	995 (51.2)
Age, years [m (sd)]		7.09 (0.64)	7.06 (0.64)	7.08 (0.64)
Grade 1, n (%)		550 (51.3)	474 (54.4)	1024 (52.7)
Migration background, n (%)	297	318 (35.1)[1]	207 (28.0)	525 (31.9)
Anthropometry				
BMIPERC, [m (sd)]	50	49.13 (28.07)	48.75 (27.67)	48.96 (27.88)
Waist circumference, cm [m (sd)]	54	55.72 (5.87)	55.41 (5.89)	55.58 (5.88)
WHtR,[m (sd)]	55	0.45 (0.04)	0.45 (0.04)	0.45 (0.04)
Overweight/obesity, n (%)	50	107 (10.3)	83 (9.7)	190 (10.0)
Abdominal obesity, n (%)	55	90 (8.7)	68 (8.0)	158 (8.4)
Parental characteristics				
Single parent, n (%)	265	101 (10.9)	76 (10.1)	177 (10.5)
Tertiary family educational level, n (%)	323	293 (32.7)	229 (31.6)	522 (32.2)
Household income < 1750 €, n (%)	452	113 (14.0)	94 (13.8)	207 (13.9)
Overweight/obesity (mother), n (%)	363	279 (32.1)	217 (30.5)	496 (31.4)
Overweight/obesity (father), n (%)	468	512 (62.3)	386 (59.1)	898 (60.9)
Abdominal obesity (mother), n (%)	916	275 (49.0)	206 (44.2)	481 (46.8)
Abdominal obesity (father), n (%)	1011	386 (75.2)	306 (73.0)	692 (74.2)
Smoking (mother), n (%)	287	172 (20.7)	175 (21.2)	347 (21.0)
Smoking (father), n (%)	356	234 (29.4)	238 (30.1)	472 (29.7)
Days off work (mother), median [m (sd)]	309[a]	2 [3.09 (4.62)][2]	0 [2.36 (4.23)]	1 [2.77 (4.47)]
Employed (mother), n (%)	302	657 (72.3)	519 (70.9)	1176 (71.7)
Working hours/week (mother), [m (sd)]	21[a]	20.83 (10.68)	21.18 (11.79)	20.99 (11.18)
Days off work (father), median [m (sd)]	839[a]	0 [0.78 (2.31)][2]	0 [0.33 (1.19)]	0 [0.56 (1.87)]
Employed (father), n (%)	354	833 (95.6)	694 (96.7)	1527 (96.1)
Working hours/week (father), [m (sd)]	86[a]	43.60 (10.65)	43.99 (10.35)	43.78 (10.51)
Health and lifestyle characteristics				
Sick days, median [m (sd)]	390	5 [7.50 (7.70)]	5 [6.73 (5.97)]	5 [7.15 (6.97)]
Visits to a physician, median [m (sd)]	404	2 [2.99 (2.76)]	2 [2.95 (3.23)]	2 [2.97 (2.98)]
Playing outside > 60 min/day, n (%)	296	607 (66.6)[3]	523 (71.2)	1130 (68.6)
Physical active ≥ 4 days/week ≥ 60 min/day, n (%)	320	238 (26.6)	199 (27.3)	437 (26.9)
6 min run test, meter [m (sd)]	63	839.67 (122.88)[4]	855.28 (120.10)	846.69 (121.85)
Screen media > 1 h/day, n (%)	250	144 (15.4)	100 (13.2)	244 (14.4)
Sugar sweetened beverages > 1 time/week, n (%)	241	236 (25.1)	180 (23.6)	416 (24.4)
Skipping breakfast, n (%)	236	97 (12.7)	126 (13.4)	223 (13.1)

m mean, *sd* standard deviation, *WHtR* Waist-to-height ratio, [a] with regard to those who stated an employment
[1] $p = 0.002$, [2] $p < 0.001$, [3] $p = 0.048$, [4] $p = 0.006$

and baseline values for sick days. First grade children in the intervention and control group had a change of −5.15 vs. -3.64, respectively, in the numbers of sick days between baseline and follow up, indicating a group difference of 1.51 days ($p = 0.02$). ICC for the differences in sick days was 0.045 (95% CI [0.012; 0.078]), thus indicating that 4.5% of the overall variance was due to the clustering of data in schools. The subsequent analysis in a linear mixed model controlling for data clustering showed no differences in regression coefficients compared to the simple linear regression model; the latter is shown in Table 4.

The difference for maternal days off work lost its significance after adjusting for its baseline values and a random school effect. No intervention effects were found for the paternal days off work and the number of the child's visits to a physician. These results were confirmed

Table 3 Differences between baseline (2010) and follow-up (2011) in the BW Study

	Missing values	Intervention ($n = 745$)	Control ($n = 634$)	Total ($n = 1379$)
Sick days, m (sd)	69	−3.18 (7.08)[1]	−2.31 (5.56)	−2.78 (6.44)
Visits to a physician, m (sd)	126	−0.85 (2.41)	−0.93 (2.70)	−0.88 (2.54)
Days off work (mother), m (sd)	647	−1.11 (3.89)[2]	−0.52 (2.84)	−0.85 (3.48)
Days off work (father), m (sd)	906	−0.25 (2.21)	0.06 (1.56)	−0.10 (1.94)

m mean, *sd* standard deviation
[1] $p = 0.013$, [2] $p = 0.019$

in linear mixed models adjusted for the respective baseline values and a random school effect.

Losses to follow-up, missing data

Datasets with any information on the outcome variables ($n = 1379$) were compared to those with completely missing outcome variables ($n = 564$). Those with completely missing outcome variables showed manifold significant baseline differences compared to the others. Lost participants were more likely to be male and to have a migration background; they had larger WC and WHtR and were more often overweight and obese. Their parents were more often single parents, had less often tertiary family education level, and more often a lower household income. Their mothers were more often overweight or obese, both parents were more likely to smoke and mothers were more often unemployed. Children had more sick days in the preceding year of kindergarten or school, they reached shorter distances in the 6 min run test, were more likely to use screen media for more than one hour per day, consumed more sugar sweetened beverages and were more likely to skip breakfast.

Discussion

The effectiveness of multicomponent health promotion in a low-threshold approach is not easily determined in a limited time period. The intervention group shows a stronger downward trend than the control group in all outcome variables except the number of visits to a physician. Only the reduction of sick days in first grade pupils remains statistically significant. This reduction in the number of sick days in the intervention group may result from behavioral changes in physical activity, nutrition, and media consumption, as described by Kobel et al. [16], but also from a reduced incidence in abdominal obesity (unpublished data), which is, as mentioned in the background section, correlated with higher rates of sick days [3]. Although the mean group difference of one sick day seems small for the individual child, this adds up to 550 days for all first grade children in the intervention group, which is a significant number. Small individual effects which benefit the whole group are the typical results of a public health intervention [24].

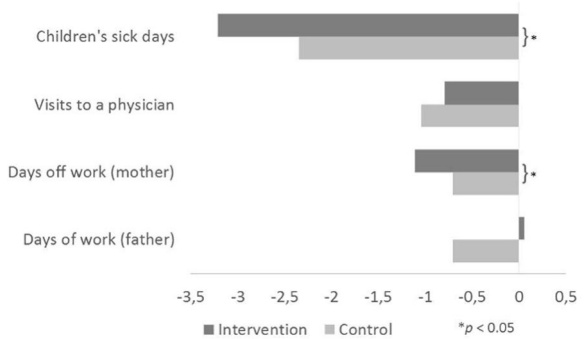

Fig. 2 Longitudinal changes in outcome parameters between baseline (2010) and follow-up (2011) in the BW Study. Numerical changes during the period under observation regarding children's sick days ($n = 1310$), children's visits to a physician ($n = 1253$), maternal days off work ($n = 473$), and paternal days off work ($n = 732$) in order to care for a sick child

There is, assumedly, a natural decline in the number of sick days from kindergarten through the first years of primary school, which may at least partly be comprehensible with regard to the natural maturing of the immune system. Furthermore, parents may be more reluctant to keep their children at home as soon as they attend school, rather than they would have been during the time in kindergarten. Nonetheless, a small but statistically significant difference between intervention and control group was detected for the decline in sick days in first grade children. Despite being small, this is an important result for various reasons. Firstly, it shows the positive impact of health promotion on health itself. Secondly, the first year of school may be regarded as crucial with respect to the complete education life-cycle and therefore missing fewer days at school may affect school success.

The missing significance of longitudinal changes in sick days between intervention and control group in grade 2 may have several reasons. First, second grade children and parents are meanwhile familiar with school and the initial enthusiasm and attention to new information has settled and come to a normal extend. This means, school is now day-to-day life for both, parents and children, and they have developed a certain routine. Hence, first grade children (and their parents) may be more susceptible and eager to learn and implement new, alternative behaviours. Second, the decrease of sick days

Table 4 Results of the linear regression analysis for the change in children's sick days between baseline (2010) and follow-up (2011) in the BW Study

	All ($n = 1268$)			Grade 1 ($n = 654$)		
Covariate	*B (SE)*	*β*	*p*-Value	*B (SE)*	*β*	*p*-Value
Intervention	−0.30 (0.22)	−0.02	0.182	−0.83 (0.28)	−0.06	0.003
Grade 1	−1.15 (0.23)	0.09	<0.001			
Female	0.30 (0.22)	0.02	0.175	0.11 (0.28)	0.01	0.708
Migration background	0.49 (0.26)	0.03	0.060	0.59 (0.34)	0.04	0.085
Sick days baseline value	−0.74 (0.02)	0.77	<0.001	−0.78 (0.02)	0.83	<0.001
R^2	0.62			0.69		

B regression coefficient, *SE* standard error, *β* standardized regression coefficient

in grade 2 is overall smaller than in grade 1: While at follow-up parents of first graders report 4.5 sick days less in the past year of school, second graders missed just one day less. In both cases the decline was greater in the intervention group, but too small to reach significance in second graders. Therefore, it seems the natural decline is greater during the first year of school and there might be a chance for health promoting interventions to enhance this decline.

We did not find significant differences between intervention and control in the parental days off work in the present study, but the number of days suggests that predominantly mothers stay at home to care for a sick child (2.8 ± 4.5 vs. 0.6 ± 1.9). There may be an association with the fact that mothers report a lower amount of working hours than fathers (21.0 ± 11.2 vs. 43.8 ± 10.5).

Despite no significant difference between groups, children's amount of visits to a physician showed an overall reduction with slightly higher numbers in the control group. This overall reduction can be related to the reduction in children's sick days. If children are less often sick, it seems reasonable that they less often need to see a doctor.

To the authors' knowledge, there is currently little information available in scientific literature with regard to the effect of school-based health promotion on the sickness absence of pupils. In their comprehensive review on cluster-randomized trials for school-based health promotion, Langford et al. reported only two studies on hand hygiene campaigns and their effect on absence rates [25]. Both studies detected significant differences in sickness episodes as well as in the median days of absence in the respective intervention groups [26, 27]. Unfortunately, due to basically different intervention components and differing economic levels of the respective countries [28], outcomes are not comparable to those presented here.

Sick days and correlates

It is not surprising, that those children with higher numbers of sick days at baseline are more likely to experience a higher reduction. There was no statistically significant effect of a migration background visible in both regression models; although those children often represent a vulnerable group, difficult to reach, and often affected by other unfortunate determinants like higher consumption of sugar sweetened beverages and screen media [29]. In the cross-sectional baseline analysis of sick days, children with a migration background were significantly more likely to have higher rates of absenteeism [3]. Nonetheless, according to the relatively high percentage of children with a migration background in this study (31.9%), the standardized effect is smaller than expected (0.03). Other research on the effectiveness of the program "Join the Healthy Boat" did not find a migration effect either (unpublished data).

Some authors discuss school absenteeism in the context of obesity, reporting predominantly positive relationships [5–10]. In our baseline analysis we found a significant correlation of sick days with abdominal obesity, children with a WHtR at or above 0.5 were almost twice as likely to have higher rates of absenteeism [3]. In the longitudinal effects of the present health promotion program, no significant association of any obesity measure with sick days was found, but changes in both, abdominal obesity (unpublished data) and sick days as presented here, were affected by the intervention.

Sick leave is undoubtedly hazardous to school success. Baxter et al. found a highly significant inverse relationship between academic achievement and absenteeism in fourth-graders in South-Carolina, USA [6]. In a large study with more than 6000 students aged 14- to 15-years at secondary schools in Iceland, Sigfúsdóttir et al. reported similar associations of absenteeism and academic achievement [30]. Hence, school-based health promotion may have an important impact on school success.

Strengths and limitations

The present study covers a statewide approach of health promotion in primary schools. Together with the results of the cost-effectiveness analysis (unpublished data), this study shows the effectiveness of this approach, and delivers valuable information for policymakers. According

to an extensive publication by the WHO "Evaluation in health promotion" among others "suffers from a shortage of evidence on the effectiveness of initiatives" while "funding agencies most commonly require evidence of effectiveness and particularly cost-related effectiveness" [31].

Randomized controlled trials in the field of health promotion are not a general rule, and reviewers always request well-conducted studies of high quality [2, 25]. The strength of the present research lies in its design, plan and conduct as a cluster-randomized, prospective, controlled study based on a publicly available study protocol [12]. Furthermore, the high number of participating schools, classes and pupils, as well as the high return rate of parental questionnaires, contributes to the good quality of this research.

Some sources of bias have to be addressed. Despite an elaborate randomization procedure, some baseline imbalances appeared. This may bias the results and is one of the reasons why baseline-values of the outcome variables were included in the regression analyses in order to minimize the bias. All outcome variables were assessed in questionnaires and were not measured directly and may therefore be subject to recall bias. Parents may not have remembered the exact amount of sick days of their children as well as the exact number of days, one parent had to stay at home to care for a sick child. The same applies to the numbers of visits to a physician. Additionally, there may have been a selection bias on the teacher level as well as on the level of participating parents. Teachers had to opt-in to take part in the program, and parents had to give their written informed consent for participation.

Another inherent problem of this kind of study comprising a wait-list control group is the potential contamination of the control. All teachers who opted-in to take part in the program were asked to take part in the outcome evaluation as well. This means that all participating teachers were highly interested in school-based health promotion. Many of the teachers who were then assigned to the control group may have already included health promotion activities in their teaching routine. Thus, the differences in the outcome measures might be reduced as a result of the contamination.

Studies with an observational character like this one often lack complete data. For this reason, a comprehensive analysis of datasets with missing values and losses to follow-up was conducted. These analyses always show a similar pattern, those participants who are lost for the analysis of effects, are those who would have been of greatest interest. This means, in the present case, children with higher numbers of sick days in the preceding year of the baseline measurements and children with a migration background. It may be assumed that the availability of these datasets for analysis would have strengthened the precision and significance of the results.

Conclusion

School-based health promotion implemented by teachers within the program "Join the Healthy Boat" has a small but statistically significant impact on the number of sick days in first grade children. This means, participating children in their first grade miss on average one day less because of ill health. Subsequently, parents may not need to stay off work themselves. Small individual effects add up to larger benefits in a statewide implementation of health promotion. Additionally, health promotion may also positively contribute to school success.

Abbreviations

ADHD: Attention deficit hyperactivity disorder; BMI: Body mass index; BMIPERC: BMI percentiles; BW: Baden-Württemberg; CASMIN: Comparative analysis of social mobility in industrial nations; DRKS: German clinical trials register; ICC: Intraclass correlation coefficient; ISAK: International society for the advancement of Kinanthropometry; MVPA: Moderate to vigorous physical activity; SPSS: Statistical package for the social sciences; WC: Waist circumference; WHO: World Health Organization; WHtR: Waist-to-height ratio

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Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to reasons of data protection but are available from the Institute of Epidemiology and Medical Biometry, Ulm University, on reasonable request.

Authors' contributions

DK and other members of the research group planned and organized the Baden-Württemberg study, and were involved in carrying out the measurements in fall 2010. DK performed the statistical analyses. JMS is the director of the program "Join the Healthy Boat – primary school" and principal investigator of the Baden-Württemberg Study. DK, MT and RL drafted the manuscript. TK and JMS revised the manuscript drafts. All authors have read and approved the final version of the manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication
Not applicable.

Ethics approval and consent to participate
The study protocol was approved by the ethics committee of Ulm University in June 2009 (Application No. 126/10). The Baden-Württemberg Study is registered at the German Clinical Trials Register (DRKS) Freiburg University, Germany, under the DRKS-ID: DRKS00000494. Written informed consent was obtained from parents and teachers.

Author details
[1]Division of Sport and Rehabilitation Medicine, Ulm University Medical Center, 89075 Ulm, Germany. [2]Ulm University, Institute of General Medicine, Helmholtzstraße 20, D-89081 Ulm, Germany. [3]Department of Computer Science, Ulm University of Applied Sciences, 89081 Ulm, Germany.

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RESEARCH ARTICLE

Costs and effects of a state-wide health promotion program in primary schools in Germany – The Baden-Württemberg Study: A cluster-randomized, controlled trial

Dorothea Kesztyüs[1,2☯]*, Romy Lauer[1☯], Tibor Kesztyüs[3], Reinhold Kilian[4], Jürgen M. Steinacker[1], on behalf of the "Join the Healthy Boat" Study Group[¶]

1 Section Sports and Rehabilitation Medicine, Department of Internal Medicine II, Ulm University, Ulm, Germany, **2** Institute of General Medicine, Ulm University, Ulm, Germany, **3** Department of Computer Science, Ulm University of Applied Sciences, Ulm, Germany, **4** Section Health Economics and Health Services Research, Department of Psychiatry II, Ulm University, Günzburg, Germany

☯ These authors contributed equally to this work.
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* dorothea.kesztyues@uni-ulm.de

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Data Availability Statement: Data are available from the Institute of Epidemiology and Medical Biometry at Ulm University for researchers who meet the criteria for access to confidential data. Contact information: Ulm University Institute of Epidemiology and Medical Biometry, Schwabstraße 13, 89075 Ulm, Germany. E-Mail: med.biometrie@uni-ulm.de; Phone: +49 731 5026901; Fax: +49 731 5026902.

Abstract

Aim

To evaluate the cost-effectiveness of the state-wide implementation of the health promotion program "Join the Healthy Boat" in primary schools in Germany.

Methods

Cluster-randomized intervention trial with wait-list control group. Anthropometric data of 1733 participating children (7.1 ± 0.6 years) were taken by trained staff before and after a one year intervention period in the academic year 2010/11. Parents provided information about the health status, and the health behaviour of their children and themselves, parental anthropometrics, and socio-economic background variables. Incidence of abdominal obesity, defined as waist-to-height ratio (WHtR) $\geq$ 0.5, was determined. Generalized linear models were applied to account for the clustering of data within schools, and to adjust for baseline-values. Losses to follow-up and missing data were analysed. From a societal perspective, the overall costs, costs per pupil, and incremental cost-effectiveness ratio (ICER) to identify the costs per case of averted abdominal obesity were calculated.

Results

The final regression model for the incidence of abdominal obesity shows lower odds for the intervention group after an adjustment for grade, gender, baseline WHtR, and breakfast habits (odds ratio = 0.48, 95% CI [0.25; 0.94]). The intervention costs per child/year were €25.04. The costs per incidental case of averted abdominal obesity varied between €1515 and €1993, depending on the different dimensions of the target group.

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Competing interests: The authors have declared that no competing interests exist.

Conclusion

This study demonstrates the positive effects of state-wide, school-based health promotion on incidental abdominal obesity, at affordable costs and with proven cost-effectiveness. These results should support allocative decisions of policymakers. An early start to the prevention of abdominal obesity is of particular importance because of its close relationship to non-communicable diseases.

Trial registration

German Clinical Trials Register (DRKS), Freiburg University, Germany, DRKS-ID: DRKS00000494.

Introduction

As a result of the globalization of unhealthy lifestyles, characterized by poor diet and physical inactivity, obesity is one of the most discussed risk factors for non-communicable diseases (NCDs) worldwide [1]. These diseases are currently the world's main killers, totalling 63% of all deaths. The economic burden of NCDs is substantial. Macroeconomic simulations suggested a cumulative output loss of 75% of global gross domestic product (GDP) in 2010 [1]. Several NCDs are associated with the metabolic syndrome, in which abdominal obesity is the most obvious and prevalent constituent [2]. Rates of abdominal obesity are rising; although some researchers report a levelling off, or plateauing of obesity, as defined by body mass index (BMI) [3, 4, 5]. Weight gain most often starts in early childhood and frequently persists into adulthood [6, 7]. Many obese children already show metabolic complications and are at high risk for the development of early morbidity [8]. Timely initiation of evidence-based prevention and health promotion addressing children, parents, caregivers, and teachers is urgently needed to reverse the trend.

Programs for health promotion and prevention in the school setting are ubiquitous, and some have proven their effectiveness [9]. With regard to limited resources, it is essential to learn more about the cost-effectiveness of those programs and interventions.

In their extensive systematic Cochrane review on interventions for preventing obesity in children in 2011, Waters and colleagues did not find any study that included a formal economic evaluation [9]. In 2014, Langford and colleagues found only two studies on cost-effectiveness in their Cochrane review of the WHO health promoting school framework [10]. John and colleagues, who focused especially on the cost-effectiveness of interventions on paediatric obesity, found less than 10 studies on preventive measures in 2012 [11]. One of the studies, presented in both reviews by Langford as well as by John, was the "Ulm Research on Metabolism, Exercise and Lifestyle Intervention in Children" (URMEL-ICE). Assuming a parental willingness to pay €35/year, the URMEL-ICE intervention was cost-effective in preventing children from an increase in abdominal girth [12]. Based on this positive result, the intervention mentioned was revised, and renamed as the "Join the Healthy Boat" health promotion program; it spread throughout the state of Baden-Württemberg in southern Germany. Health economic results from the outcome evaluation of this "Baden-Württemberg Study" shall be presented here.

Aims

The purpose of the present study was to assess the cost-effectiveness of a school-based, state-wide, health promotion program. Therefore, the costs were assessed in detail, calculated in total and per capita, and were compared to the number of averted cases of incidental abdominal obesity.

Participants and methods

Study description

The "Baden-Württemberg Study" was the outcome evaluation of the school-based, health promotion program, "Join the Healthy Boat", and was designed as a cluster-randomized, controlled intervention trial. The stratified cluster-randomization process resulted in an approximately balanced randomization [13]. Blinding was not feasible. Sample size calculations were based on available data for the primary outcome waist circumference (WC) [13]. The primary outcome measures for the health economic analysis were longitudinal changes in WC and waist-to-height ratio (WHtR).

The study was conducted throughout the state of Baden-Württemberg, which is located in southern Germany. The intervention group was comprised of schools where teachers had successfully completed the vocational training and implemented the "Join the Healthy Boat" intervention in the academic year 2010/2011. The teachers in the schools of the control group, representing the alternative in the economic analysis, continued to teach as normal and were obliged to wait one year before they could take part in the vocational training. Approval from the Ethics Committee of Ulm University and written informed consent from parents was obtained. The study was registered on the German Clinical Trials Register (DRKS), Freiburg University, Germany, under the DRKS-ID: DRKS00000494. Detailed information concerning the trial has already been published elsewhere [13].

Intervention

The health promotion program, "Join the Healthy Boat", developed by the scientific researchers of Ulm University, targets the healthy lifestyle of primary school children in grades 1 to 4, and also focuses on the prevention of children becoming overweight and obese. To guarantee systematic and evidence-based development, the evaluation and implementation of the program, the intervention mapping approach, [14] as well as the social cognitive theory [15] and the socio-ecological model [16], were utilized. The three main topics of the program are the promotion of physical activity, the reduction in intake of sugar-sweetened beverages and the reduction of screen media consumption. All intervention materials were integrated into the regular curriculum; no extra lessons were required. As well as course materials for the teachers, the intervention materials include materials for children (e.g. activity breaks) and for parents (e.g. family homework and information material).

In order to ensure the state-wide implementation of the program, a "train-the-trainer" concept was applied. For this purpose, 32 experienced teachers, spread all over Baden-Württemberg, were trained intensively in the concept and the materials, and attended seminars, provided by the scientific staff of Ulm University, twice a year. Those teachers, further referred to as "consulting teachers", in turn, trained teachers in their regions ("peer-to-peer") in three vocational training sessions, in order to provide them with the necessary knowledge and practical skills to apply the program in their classes. More detailed information about the intervention, the data collection, the randomization process, and the sample size calculation can be found in the published study protocol, S1 Protocol,[13].

Participants

The 32 consulting teachers offered vocational training in their respective regions. Recruitment took place in the academic year 2009/2010, when teachers who applied for these training sessions in the following year were asked to participate in the outcome evaluation. This resulted in 157 classes in 86 schools, which were part of the baseline measurements in 2010, and 154

classes in 84 schools in the follow-up, one year later. In total, 439 teachers participated in those training sessions, of which 81 were engaged in the intervention. The parents of 1968 pupils in grade one and grade two gave their written informed consent. Fig 1 shows a flowchart with the respective numbers of schools, teachers and their classes at each stage of the trial. The corresponding number of participants or available datasets, respectively, is depicted in Fig 2.

Data collection

Data collection took place at the beginning of the academic year, in fall 2010 (baseline), and fall 2011 (follow-up), respectively. A team of scientific researchers and trained students visited each participating school and carried out the measurements of the children. Parents received self-administered questionnaires.

Questionnaires and derived variables. Both parents were asked to specify their educational level and their monthly household income. They were invited to report their height, weight and waist circumference, and whether they were current smokers.

Mothers had to indicate their age at the time of giving birth, whether they had gestational diabetes or smoked during pregnancy, and whether the child was breastfed. A migration status of the child was assumed if at least one parent was born abroad or at least one parent mainly spoke a foreign language during the child's first years of life. Additionally, single parenthood

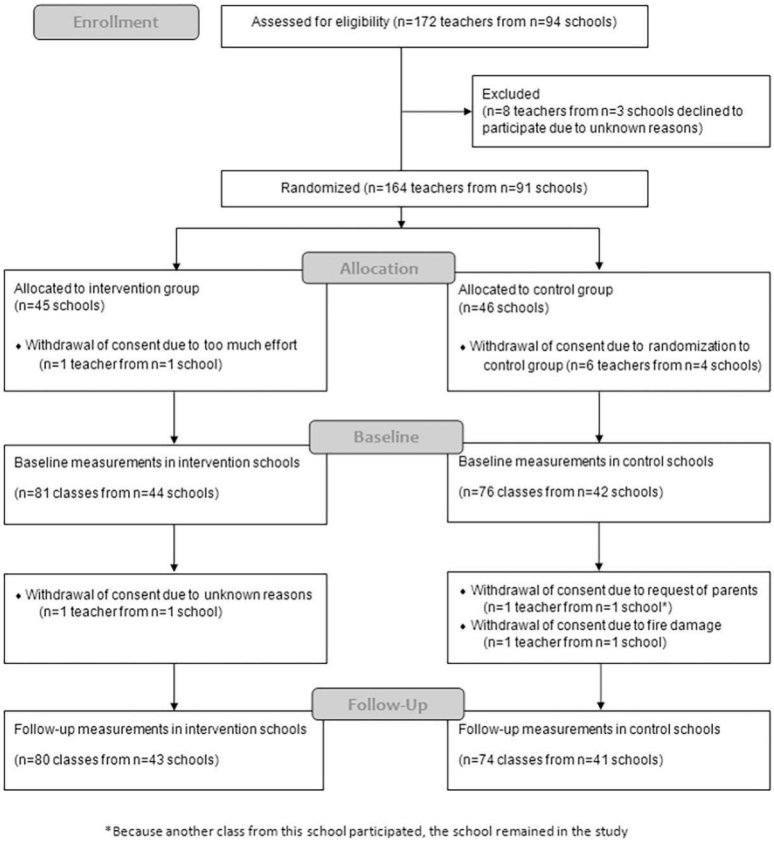

Fig 1. Flowchart of enrollment, baseline measurements, and follow-up of teachers, classes and schools in the Baden-Württemberg Study. Adapted from "Evaluation of a health promotion program in children: Study protocol and design of the cluster-randomized Baden-Wuerttemberg primary school study [DRKS-ID: DRKS00000494].," by Dreyhaupt J, Koch B, Wirt T, Schreiber A, Brandstetter S, Kesztyues D, et al. BMC Public Health. 2012;12(1):157. Copyright 2012 by Dr. Jens Dreyhaupt. Adapted with permission.

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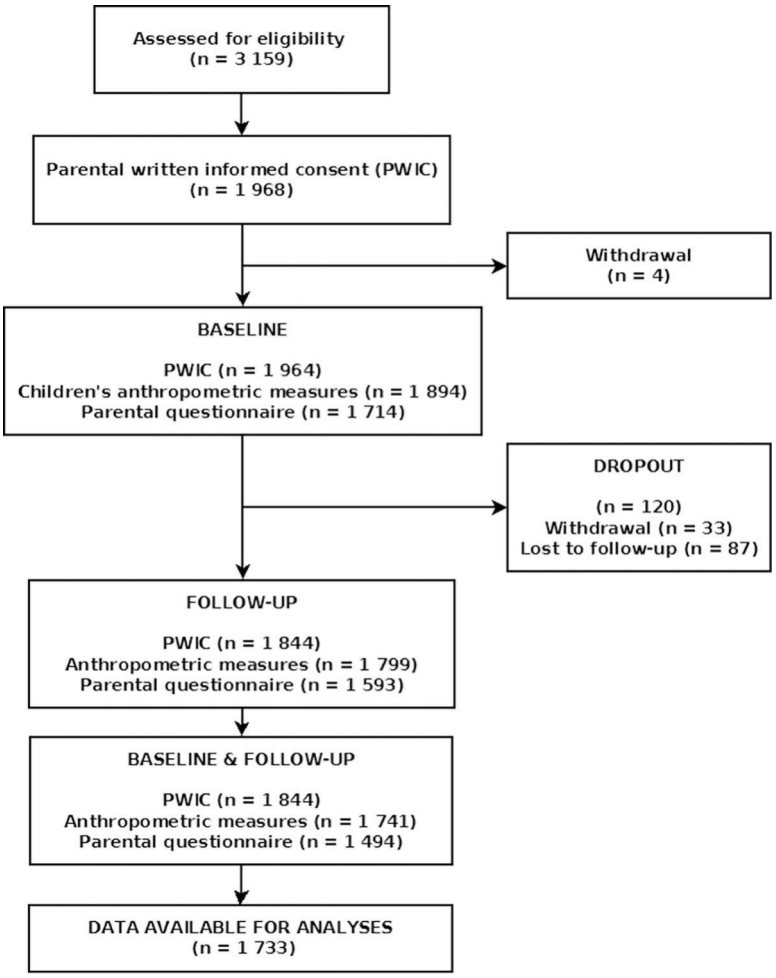

Fig 2. Flowchart of participants/datasets in the Baden-Württemberg Study.

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was assessed. As parameters of the health behaviour of the children, the daily time of outdoor play, the number of days per week they met the WHO guideline of moderate to vigorous physical activity (MVPA) of more than 60 minutes, the amount of screen media consumption, the consumption of sugar sweetened beverages, and breakfast habits were assessed.

Family educational level was ranked in accordance with the CASMIN classification system as the highest level of two parents or the level of a single parent [17]. It was dichotomized for analysis into tertiary level, on the one side, versus primary and secondary level on the other side. Monthly household income was grouped into a low ($<$ €1750) and a high ($\geq$ €1750) category. Outdoor play time was dichotomized into $>$ 60 min/day and $\leq$ 60 min/day. Reaching the WHO Guideline for MVPA on at least four days a week was compared to reaching it on less than four days. The use of screen media was divided into $>$ 60 min/day and $\leq$ 60 min/day, and the consumption of sugar sweetened beverages into more than one time per week and one time or less. Having breakfast was divided into "never" and "rarely" vs. "often" and "every day".

Anthropometrics. Anthropometric measurements of the children were taken by trained staff, according to the International Society for the Advancement of Kinanthropometry (ISAK) standards [18]. Weight and height were measured using calibrated flat scales, respectively mobile stadiometers (both by Seca® Company, Germany). Body Mass Index (BMI) was

calculated by the quotient of weight in kilograms and height in m^2 and converted to BMI percentiles using German reference data [19]. WC was measured precisely halfway between the iliac crest and the lower costal border in centimetres using a metal tape measure (Lufkin® Industries Inc., Texas, USA). WHtR was calculated by the ratio of WC and height in centimetres. A WHtR $\geq$ 0.5 was determined as abdominally obese [20].

Parental weight, height and WC were assessed by the parents in a self-report, and BMI and WHtR were converted by the researchers from the relevant parameters. A parental BMI $\geq$ 25 was categorized as overweight and a BMI $\geq$ 30 as obese [21].

Assessment of intervention costs. The chosen perspective for the evaluation was a societal one that implies a collection of all costs and consequences incurred during the one year intervention period in 2010/2011 [22]. A bottom up, micro-costing approach was applied with the detailed collection of data of resource use [23]. The costs regarding the development and evaluation of the intervention were not included, only the costs for the delivery of the intervention in a routine manner were assessed at the time of incurrence.

The costs were divided in those of two seminars for each of the 32 consulting teachers, costs of three vocational training sessions for participating teachers, and personnel costs. All costs were assessed and described as accurately and in as much detail as possible.

Costs for seminars included personnel costs for speakers, rent of seminar rooms, subsistence costs, travel expenses and hotel costs for consulting teachers, materials (folders, CDs, copies), letters and envelopes, postal charges, and distributed folders. Costs for vocational training contained copies for both consulting teachers and participating teachers, materials (CDs, files, sheets etc.), subsistence costs, distributed folders, shipping envelopes and postal charges for materials, advertising materials (poster, flyer, brochures), and costs for the process evaluation of the vocational training sessions including post-paid envelopes and postal charges. The personnel costs included the salary of consulting teachers, the secretary and six researchers.

Most of the costs were assessed alongside the intervention, and therefore represent the exact prices and real market prices of the reference year 2011. Some unrecorded costs in the evaluation period, e.g. the exact amount of printed pages for the seminars, were estimated, but close to the original amounts and prices. No labour costs for participating teachers were added to the costs as the intervention was included in the curriculum.

The total costs were calculated by multiplying the quantity and the unit costs for each item. All positions were weighted with the factor 81/439, as 81 out of 439 teachers participated in the evaluation. For the calculation of the costs per child, the entire number of pupils in the intervention classes (n = 1458) was used, assuming that all children benefited from the intervention, independent of their study participation.

No discounting was applied because the period under consideration lasted only one year. No unintended consequences (e.g. side effects or adverse outcomes) or intangible costs were expected. Costs as well as effects concerning the intervention were compared to "doing nothing", respectively the later start of the intervention in the waiting control group.

Calculation of the Incremental Cost-Effectiveness Ratio (ICER. The incremental cost-effectiveness ratio (ICER) is defined as the ratio of net intervention costs and net intervention effects, with C_I representing the average costs per participant in the intervention group, and C_C the average costs per participant in the control group, which in the present study equals zero:

$$ICER = \frac{C_I - C_C}{E_I - E_C} = \frac{\Delta C}{\Delta E}$$

Likewise E_I and E_C represent the average effects in their respective group, in this study $E_I - E_C$ stands for the number of cases of abdominal obesity averted.

The ICER is calculated for several numbers of participants reached by the intervention. For that purpose, the incidence rates of abdominal obesity of the study population at follow-up (n = 1733) in the intervention (2.2%, 95% CI [1.3; 3.1]) and control group (3.5%, 95% CI [2.2; 4.8]) were applied firstly to the number of participants in the intervention group as intended to treat (n = 1072); secondly as the number available on follow-up (n = 955); thirdly on datasets without missing variables for regression analysis (n = 847); and fourthly for the extrapolation to all children (n = 1458), who belonged to the participating study classes of the intervention group (including those without agreement for study participation). Finally, the above-mentioned incidence rates were used for the extrapolation of cases averted by the estimated number of all children (n = 40000), who were reached by the intervention until the academic year 2013/14.

Sensitivity analysis. Since the data for this research was of primary nature and no modelling was performed, sensitivity analyses are restricted. Variables for sensitivity analyses are mainly the respective differences in costs and effects. As no individual different costs per child, teacher or school incurred, there was no variation in costs to enter into a sensitivity analysis. Concerning effectiveness, it seems possible that the reduction in the incidence rate of abdominal obesity in another country may be higher or lower. Therefore, we calculated the ICER for the costs of cases averted at a 10% and 20% higher and lower effect, respectively, on the incidence rate.

Losses to follow-up, missing data. Losses to follow-up and missing data are common problems in observational trials, and may bias the results. To examine baseline differences between participants who took part in both measurements and those who were lost to follow-up, the Mann-Whitney-*U* test for continuous data, and Fisher's exact test for categorical data were used. The same applies for differences between records with complete data for the regression analyses and those who were excluded because of missing explanatory variables. Reasons for losses to follow-up of participating children were family relocation, grade repetition, and sick leave.

Statistical analysis. The descriptive analysis of the baseline data included all variables that were considered meaningful for the characterization of the groups and were established, or supposed correlates, of the key values. Differences between intervention and control, as well as differences between weight groups, were tested with respect to the scale level and the underlying distribution with Fisher's exact test for categorical data and t-test, Mann-Whitney *U* test or Welch-test (considering heterogeneity in variance) for continuous data. Significance level was set to $\alpha < 0.05$ for two-sided tests. WHtR was multiplied by 10 for the regression analysis to facilitate the interpretability of results, so one unit in the regression model represents 0.10 WHtR.

The adjusted effect for the key value "incidental abdominal obesity" was analysed in a logistic regression with the stepwise selection of all variables from Table 1, except those of children's anthropometrics. In a further step, the missing values of the predictor "skipping breakfast" were imputed with a random draw from the Bernoulli distribution of the variable, and this was done separately for boys and girls. A potential clustering effect in schools was tested in a two-level model (generalized linear mixed model).

Descriptive and bivariate statistics were conducted with IBM SPSS Release 21.0 for Windows (SPSS Inc, Chicago, IL, USA). Linear and logistic regression models as well as multi-level models to account for the clustering of data were calculated with the statistical software package R Release 3.1.2 for Windows (http://cran.r-project.org).

Table 1. Baseline characteristics of participants in the Baden-Württemberg Study.

	Missing values	Intervention (n = 955)	Control (n = 778)	Total (n = 1733)
Boys, n (%)		481 (50.4)	372 (47.7)	852 (49.2)
Age, years [m (sd)]		7.09 (0.63)	7.06 (0.63)	7.08 (0.63)
Migration background, n (%)	244	**280 (34.2)****	182 (27.2)	462 (31.0)
Anthropometrics				
BMIPCT, [m (sd)]		48.92 (27.80)	48.09 (27.48)	48.55 (27.65)
WHtR, [m (sd)]		0.449 (0.038)	0.447 (0.040)	0.448 (0.039)
Overweight incl. obesity, n (%)		96 (10.1)	69 (8.9)	165 (9.5)
Obesity, n (%)		41 (4.3)	27 (3.5)	68 (3.9)
Abdominal obesity, n (%)		80 (8.4)	55 (7.1)	135 (7.8)
Pregnancy and birth				
Mother´s age at birth, [m (sd)]	258	30.11 (5.08)	30.76 (5.04)	30.40 (5.07)
Gestational diabetes, n (%)	205	30 (3.6)	31 (4.5)	61 (4.0)
Smoking during pregnancy, n (%)	196	94 (11.2)	62 (8.9)	156 (10.1)
Breastfeeding, n (%)	194	708 (83.6)	578 (83.5)	1286 (83.6)
Parental characteristics				
Single parent, n (%)	218	90 (10.8)	66 (9.7)	156 (10.3)
Tertiary family educational level, n (%)	269	268 (33.2)	207 (31.6)	475 (32.4)
Household income < 1750 €, n (%)	381	94 (12.8)	77 (12.4)	171 (12.6)
Overweight/obesity (mother), n (%)	300	247 (31.4)	193 (29.8)	440 (30.7)
Overweight/obesity (father), n (%)	392	463 (62.2)	354 (59.3)	817 (60.9)
Abdominal obesity (mother), n (%)	788	255 (49.6)	192 (44.5)	447 (47.3)
Abdominal obesity (father), n (%)	871	352 (74.9)	290 (74.0)	642 (74.5)
Smoking (mother), n (%)	236	**184 (22.4)***	119 (17.6)	303 (20.2)
Smoking (father), n (%)	295	246 (31.2)	172 (26.5)	418 (29.1)
Health and lifestyle characteristics				
Playing outside > 60 min/day, n (%)	248	**547 (66.5)***	473 (71.3)	1020 (68.7)
MVPA $\geq$ 4 days/week $\geq$ 60 min/day, n (%)	263	216 (26.7)	183 (27.7)	399 (27.1)
Screen media > 60 min/daily, n (%)	205	122 (14.5)	83 (12.1)	205 (13.4)
Soft drinks > 1 time/week, n (%)	197	208 (24.6)	156 (22.6)	364 (23.7)
Skipping breakfast, n (%)	195	109 (12.9)	89 (12.9)	198 (12.9)

m (mean), sd (standard deviation)

** $p < 0.01$

* $p < 0.05$.

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Results

Baseline characteristics

There were some differences between the intervention and control group in the baseline characteristics of participants shown in Table 1. More children with a migration background existed in the intervention group. Moreover, children in the intervention group seemed to be less active in playing outside and their mothers more often smoked. These variables were included in subsequent regression analyses.

Losses to follow-up, missing data

The analysis of the baseline data for those who participated in the study at both measurements, and those for whom only baseline values were available, showed some differences. Children

Table 2. Changes baseline—follow-Up.

	Missing	Intervention (n = 955)	Control (n = 778)	Total (n = 1733)	*p*-value
Anthropometrics					
BMI percentile, [m (sd)]	5	**0.67 (10.34)**	0.17 (10.17)	0.45 (10.26)	**0.038**
WHtR, [m (sd)]		-0.007 (0.022)	-0.008 (0.022)	-0.008 (0.022)	0.162
Incidence overweight, n (%)	5	29 (3.1)	19 (2.4)	48 (2.8)	0.466
Remission overweight, n (%)	5	12 (1.3)	11 (1.4)	23 (1.3)	0.835
Incidence obesity, n (%)	5	10 (1.1)	5 (0.6)	15 (0.9)	0.440
Remission obesity, n (%)	5	5 (0.5)	4 (0.5)	9 (0.5)	1.000
Incidence abdominal obesity, n (%)		21 (2.2)	27 (3.5)	48 (2.8)	0.140
Remission abdominal obesity, n (%)		10 (1.0)	14 (1.8)	24 (1.4)	0.217

m (mean), sd (standard deviation)

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who participated only in the baseline measurements were more frequently overweight, obese and abdominally obese and had, more often, a migration background. They spent more time with screen media and consumed more soft drinks. Their mothers were younger, smoked more often, and the household income was more frequently below €1750.

The baseline values of participants who were excluded from the regression analyses, due to missing values, differed in some variables from those with complete data. Children with missing values were more frequently overweight, obese and abdominally obese and had a single parent. They spent more time with screen media, consumed more soft drinks and less often had breakfast. Their mothers were younger and had more frequently experienced gestational diabetes. Their fathers were more often smokers. Families had fewer tertiary educational level participants, and household income was more frequently below €1750.There were no differences between the intervention and control group in the numbers of losses to follow-up, and missing data.

Intervention effects

Bivariate comparisons between the intervention group and controls concerning changes between baseline and follow-up measurements (Table 2) showed significant differences in anthropometric outcome variables, only for BMI percentiles. This difference was examined more closely in a regression analysis. The same applied to the incidence of abdominal obesity where the highest, albeit not statistically significant (p-value for a two-sided Fisher's exact test 0.14) difference, was found.

The significant effect for BMI percentiles was lost after controlling for the baseline value in the regression analysis ($p = 0.403$). The final regression model for the incidence of abdominal obesity (Table 3) shows less than half the odds for children in the intervention group to develop abdominal obesity during the period under study. This result was adjusted for grade, gender, baseline value of WHtR, and breakfast habits. No clustering effect in schools was observed. The above mentioned migration background, maternal smoking behaviour, and the playing outside of the children had no significant influence on the outcome.

To retrieve a model utilizing the complete number of available datasets, the missing values of the variable "skipping breakfast" were imputed. The resulting regression model (Table 3) differed in the proportion of explained variance, and the magnitude of the odds ratios. Particularly, the OR for the intervention group was only significant on the 10% level. Therefore, 90% confidence intervals (CI) are shown additionally in Table 3.

Table 3. Logistic regression models for the incidence of abdominal obesity with and without imputed values for skipping breakfast.

	Primary model		Model with imputation		
	(n = 1538, R^2 = 0.14[b])		(n = 1733, R^2 = 0.11[b])		
Covariates	**OR**	**95% CI**	**OR**	**95% CI**	**90% CI**
Intervention	**0.48**	**[0.25; 0.94]**	0.60	[0.33; 1.09]	**[0.37; 0.99]**
Grade 2	**0.38**	**[0.19; 0.79]**	**0.47**	**[0.25; 0.88]**	**[0.28; 0.80]**
Female	1.19	[0.62; 2.29]	1.40	[0.77; 2.54]	[0.85; 2.31]
WHtR baseline[a]	**4.34**	**[2.39; 7.88]**	**3.39**	**[2.07; 5.56]**	**[2.24; 5.14]**
Skipping breakfast	**3.68**	**[1.85; 7.33]**	**3.03**	**[1.59; 5.79]**	**[1.76; 5.22]**

OR odds ratio, CI confidence interval.

[a] multiplied by 10.

[b] Nagelkerke.

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Costs

An overview of all costs, separately displayed, for seminars for consulting teachers, vocational training sessions for participating teachers, and personnel costs can be found in Table 4. For reasons of clarity, most of the unit costs of materials were combined and presented as one price. A more detailed table providing the costs of each item assessed separately can be found in S1 Table.

The costs for two seminars for the consulting teachers added up to €2164.48, with the highest amount of money spent on the teachers´ accommodation, travel and catering. The three vocational training sessions added up to €5872.00, the distributed folders for all teachers, advertising materials and the catering were the most expensive positions. The personnel costs contained costs for consulting teachers and the staff of the university and were, in total, the highest position at €28469.93. The total amount of the intervention for one year was €36506.41, which resulted in an intervention cost of €25.04 per pupil.

Costs per case averted

The ICERs, in this scenario the costs per case of incidental abdominal obesity averted, varied between €1515 and €1993, depending on the size of the observed target group. Table 5 shows calculations for different numbers of participants reached by the intervention program.

Sensitivity analysis

Hypothetical changes in the effect of the intervention on the incidence rate of ±10% and ±20% respectively, resulted in a minimum of costs per case averted of €1789.53 and a maximum of €1963.92.

Discussion

Interpretation of findings in relation to other literature

Despite the large amount of interventions and studies focusing on the prevention of obesity in children, it is difficult to compare them with the present study. Studies often lack detailed information about the intervention components and how the intervention is implemented [10, 24, 25]. Concerning cost-effectiveness, this limited transparency aggravates the transferability to other settings and interventions [26]. Additionally, cost-effectiveness studies in general, and especially those of good quality, are scarce, [10, 24, 26]. Finally, the huge variety of

Table 4. Costs for the intervention in the year 2010/2011 in Euro.

Category	Quantity	Unit costs	Total costs	Weighted *
Two seminars for consulting teachers				
Personnel costs for speakers	1	260.00	260.00	47.97
Rent of seminar rooms	1	372.80	372.80	68.79
Subsistence costs	1	2812.87	2812.87	519.00
Travel expenses	1	3560.12	3560.12	656.88
Hotel costs	1	2713.50	2713.50	500.67
Materials (folders, CDs, copies)	1	634.36	634.36	117.05
Letters and envelopes	1	44.48	44.48	8.21
Postal charges	1	88.00	88.00	16.24
Distributed folders for consulting teachers	32	38.90	1244.80	229.68
Three vocational training sessions (only for intervention teachers)				
Copies for consulting teachers	2592	0.12	298.08	55.00
Copies for teachers	10975	0.12	1262.13	232.88
CDs, files, sheets etc.	1	264.35	264.35	48.78
Subsistence costs	32	200.00	6400.00	1180.87
Number of distributed folders	439	38.90	17077.10	3150.90
Shipping envelopes for consulting teachers for vocational training materials	1	15.84	15.84	2.92
Postal charges for shipping envelopes and packets	1	257.70	257.70	47.55
Advertising materials (poster, flyer, brochures)	1	5913.41	5913.41	1091.09
Process evaluation of vocational trainings				
Post-paid envelopes and postal charges for consulting teachers	1	78.08	78.08	14.41
Post-paid envelopes and postal charges for teachers	1	258.12	258.12	47.63
Personnel costs				
Salary of consulting teachers	29	1200.00	34800.00	6420.96
	1	700.00	700.00	129.16
Secretary (50% of working time used for intervention)	1 x 75%-position (1*37.5%)	40800.00	15300.00	2823.01
Researcher (50% of working time used for intervention)	1 x 75%-position 1 x 100%- position 4 x 50%-position (1*37.5%, 1*50%, 4*25%)	55200.00	103500.00	19096.81
Total			197855.74	36506.41
Per child (n = 1458)				25.04

* for 81 intervention teachers out of a total of 439 teachers in vocational trainings (81/439).

Note. A more detailed table providing the costs of each item assessed separately can be found in S1 Table.

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outcome measures and the predominance of modelling studies exacerbate the difficulty of comparability.

Frequently used outcome measures are BMI and BMI-related measures. To the authors' knowledge, no intervention studies evaluating the cost-effectiveness of the prevention of incidental abdominal obesity in children are available in literature. Most studies using modelling report costs per Quality Adjusted Life Years (QALY) or Disability Adjusted Life Years (DALY). However, within public health settings QALYs are difficult to apply, and the focus should rely on a much broader range of outcomes [27]. Especially complex public health interventions require measures that go beyond QALYs, e.g. non-health related outcomes such as education [27]. Furthermore, in primary prevention the target group is expected to be in good health, so QALYs are difficult to assess as they focus on disease. Lastly, there is some doubt

Table 5. Different model calculations for costs per case of abdominal obesity averted.

	Cases expected	Cases observed	Cases averted	Total costs	Costs / case averted
IG follow-up complete DS in logistic regression (n = 847)	30 [b]	16	14	847 * €25.04	€1514.92
IG follow-up (n = 955)	33 [b]	21	12	955 * €25.04	€1992.77
IG baseline (n = 1072)	38 [b]	24 [a]	14	1072 * €25.04	€1917.35
All pupils in the intervention classes (n = 1458)	51 [b]	32 [a]	19	€36506.41[c]	€1921.39
All pupils, who were approximately reached until the academic year 2013/14 (n = 40000)	1400 [b]	880 [a]	520	40000 * €25.04	€1926.15

IG intervention group, CG control group, DS data sets, CI confidence interval.

[a] Incidence rate IG (n = 955): 0.022; 95% CI [0.013; 0.031].

[b] Incidence rate CG (n = 778): 0.035; 95% CI [0.022; 0.048].

[c] see Table 4.

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concerning the validity of QALYs in pediatric economic evaluation [28]. Reviews focusing on cost-effectiveness analysis for health promotion programs for children demonstrated that few studies were just primary data studies and that a large amount of the studies were modelling studies [11, 25, 26, 29]. Because the latter are difficult to compare to the present study, the focus in this section is on primary data studies. John et al. 2010 identified twelve cost-effectiveness studies aimed at the prevention of paediatric obesity; of which ten were modelling studies and two primary data studies [25]. In the first primary data study, Wang et al. calculated for their "FitKid" after school program, per capita net intervention costs of $317 per student who attended; $\geq$ 40% of the intervention [30]. In the second primary data study, McAuley et al. assessed for their community-based APPLE-Project about NZ$641 per child per year [31]. For the update of their review in 2012, John et al. detected further economic evaluations of interventions, 10 with a model approach and one primary data study [11]. For the primary data study, Moya Martinez et al. [32] reported costs of about €270 per child per year for their after school care program and, calculated by John et al. [11], saved €500 per % point decrease in triceps skinfold thickness. Korber identified in her review eight studies which used a modelling approach and four which conducted cost-effectiveness analysis in the school setting, including the above mentioned Wang et al. and McAuley et al. [26]. The third study, Kesztyüs et al., determined the costs of the URMEL-ICE intervention, the previous incarnation of the present project, as €11.11 per cm WC- and €18.55 per unit WHtR-gain prevented [12]. The fourth study of Krauth et al. calculated €619 per student per year for their PA intervention [33]. Lobstein [29] identified 21 cost-effectiveness studies, with only three based on primary data, ranked as likely to be cost effective and already described above [30, 31, 32].

In sum, the costs of the present intervention at €25.04 per child per year are less than the reported costs of many other studies. Purchasing power parity estimates for the year 2011 enable comparisons of health costs between different countries[34]. Accordingly, after correction to inflation, the "FitKid" program would cost €218.94, the "Apple" project €391.05 and finally the "Cuenca study" of Moya Martinez and collegues €277.67 per child and year (all costs in 2011 Euros). However, Wang et al. and McAuley et al. confirm personnel as the most expensive category [30, 31]. After all, drawing conclusions about transferability, comparing interventions which used external personnel instead of training teachers, interventions conducted in different countries with different school systems and which used different outcome measures, is nearly impossible. Additionally, none of those studies provided a detailed list with all costs incurred in order to create a qualitative comparison.

Context of findings

The first school-based program initiated by Ulm University (URMEL-ICE) was successful in terms of cost-effectiveness, but it was limited to the manageable area of Ulm [12]. A broader approach was started with the "Join the Healthy Boat" health promotion program, which was designed to cover the entire state of Baden-Württemberg, southern Germany [13]. The exciting question was whether the program would be successful on such a large scale, and whether it would prove to be cost-effective. In this article, we have demonstrated the effectiveness of state-wide health promotion of abdominal obesity and reported the costs in total, per capita, and per case of abdominal obesity averted.

Abdominal obesity was a primary target for several reasons. Firstly, because obesity-related health risks are explained by waist circumference (WC), not BMI [35]; secondly because WC is sensitive towards changes in physical activity [36] and nutrition [37, 38], both components of the intervention; thirdly because BMI fails to identify obesity in a significant percentage of children [39]; and finally in the light of increasing rates of abdominal obesity in children [4, 5].

Childhood obesity very likely continues into adulthood [6, 7]. Our data shows a high prevalence of abdominal obesity in parents (47% in mothers, 75% in fathers), although we have to rely on self-reported measures by the parents. Moreover, when social desirability and underreporting are considered, the real prevalence might even be higher. Realizing the close relationship between abdominal obesity and metabolic syndrome [40], the strongest risk factor for cardio-metabolic diseases that represent the main causes of death in the developed world, the urgency for counteractive measures is obvious. Accordingly, an early start to health promotion and prevention is adequate and important. The settings of school and kindergarten offer a great opportunity to reach the major part of an important and vulnerable age group. Additionally, the involvement of social and family components, especially the inclusion of parents in an intervention, is important and has an impact on becoming overweight and obese [24]. Finally, health status and education, e.g. the capacity to learn, are related and have an important influence on later life [10].

Fighting abdominal obesity will not only have an impact on the burden of disease posed by dietary and activity related NCDs, but will also help to cut the costs of obesity. Direct costs of obesity are estimated at €22.4 billion in Germany in 2020, plus indirect costs of €3.3 billion through losses in productivity [41]. In the United States, obesity-attributable medical costs for non-institutionalized adults were estimated at $190.2 billion, or 20.6 percent of national health expenditure in 2005 [42]. Additionally, childhood obesity is responsible for $14.1 billion in direct medical costs [43]. In this context, costs of €1515 up to €1993 per case of averted abdominal obesity are a good and prudent investment. Moreover, costs per child and year of €25.04 are completely covered by the parental willingness to pay (WTP) €123 per year, assessed within the Baden-Württemberg Study and described in detail elsewhere [44].

Costs can be kept down with a teacher-driven intervention in regular lessons. This bottom-up principle is less cost consuming than a top-down expert driven intervention, because e.g. no additional costs for working time and travel incur. The costs for the intervention material itself were very limited (€38.90) and the folder is reusable any number of times for further school classes. Furthermore, once a teacher is trained, no further costs arise and teachers themselves may instruct colleagues at their school in using the materials, thus saving the costs of vocational training sessions.

The analyses of losses to follow up and missing values showed that those individuals were of specific interest as they showed higher risk behaviours for becoming overweight and obese. Therefore, it is necessary for future research to focus on the reduction of participants´ dropout rates to ensure the inclusion of vulnerable groups. However, no effect of migration was seen when included in the regression analysis.

Strengths and limitations

A strength of the present study is its cluster-randomized intervention trial design; its application throughout the complete state of Baden-Württemberg, and the collection of the data of nearly 2000 children and their parents. Furthermore, the particular costs of the intervention are directly assessed and not estimated. To the authors' knowledge, no other study has provided such a comprehensive and detailed list of all costs incurred as the present study has. Additionally, trained staff measuring the children´s anthropometrics ensures high quality and using WHtR instead of other anthropometrics such as BMI is indispensable when investigating abdominal obesity in children, the latter being a more suitable definition of obesity in children. The advanced statistical analyses are further evidence of high methodological quality.

A strength of the school-based intervention, "Join the Healthy Boat", is its aim to address the main health behaviours influencing abdominal obesity, namely physical activity, diet, and media consumption. The bottom-up approach, with teachers as enactors of the intervention, as well as the "train-the-trainer" and "peer-to-peer" concept, has several advantages compared to a top-down and expert-driven approach. Firstly, teachers training teachers implies a relationship of equals; the consulting teachers are aware of obvious obstacles and opportunities, and the trained teachers discuss more openly. Secondly, teachers can embed the intervention in their school-materials, implying constant utilization. Thirdly, teachers maintain contact with parents on a regular basis resulting in the higher involvement of parents in the intervention. Fourthly, as already mentioned, costs can be saved as no costs for personnel arise. A high valuation and appreciation of the intervention by teachers, as well as parents, can be inferred from the regular contact and discussion between teachers and the research team, as well as from the high response rate of parents returning the questionnaires.

A limitation of the present study is the voluntary participation of teachers that may involve only motivated teachers who already have a positive attitude towards health and healthy behaviour, and probably already include those topics in their classes. Furthermore, practically no "high risk schools" were present in this study. Another source of selection bias may occur at the parental level. Parents, especially those with little knowledge of the German language, may answer questionnaires only partly, or they may completely refrain from participation. Furthermore, baseline differences between the intervention and control group arose. To account for those imbalances, adequate adjustment was part of all statistical analyses. Another common problem of observational studies are the missing values and losses to follow-up that may lessen the precision of the results, therefore missing data analyses were performed and imputation considered. Lastly, questionnaires can be the source of socially desired answers and have the Hawthorne effect; the latter defined as participants behaving differently knowing they are being observed.

External validity and generalizability require the study population to be a subset of the target population. In our case, the rates of overweight and obesity observed in the participants of the present study do not differ from data that have been identified for Baden-Württemberg in a survey in German schoolchildren [45].

Implications

The health promotion program "Join the Healthy Boat" has now been extended to kindergarten, aimed at children between three and six years, including their parents. Considering the high proportion of parents with abdominal obesity, from 47% in mothers up to 75% in fathers, this program focuses exactly on the right topic. An outcome evaluation of the program in kindergarten, including an economic evaluation, will follow.

Conclusions

Prevention and health promotion, as important parts of health care, should be available to all citizens on equal terms. Prevention of abdominal obesity is of particular importance because of its association with most of the non-communicable diseases (NCD). Therefore, an early start to health promoting measures needs to be implemented. Settings like school and kindergarten are especially suitable because most of the children can be easily reached through simple and inexpensive means. Costs of €25.04 per child and year are justifiable regarding the parental willingness to pay [44], and could even be reduced by integrating key elements of health promotion in the training of teachers, and including the present program in the school curriculum. Although the training of teachers and input into the school curriculum are not part of the medical sector, it is advisable in the context of "Health in all Policies" [46] to invest cross-sectoral to improve public health. In view of the apparent need for action, in regard to the increasing health risks posed by abdominal obesity and its sequelae [47], the authors recommend the transfer of scientific results as presented in this study into political decision making.

Supporting information

S1 Checklist. CONSORT 2010 Checklist.
(DOC)

S1 Protocol. Study Protocol of the Baden-Württemberg Study.
(PDF)

S1 Table. Detailed description of costs.
(PDF)

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Author Contributions

Conceptualization: DK RL RK JMS.

Formal analysis: DK RL.

Funding acquisition: DK JMS.

Investigation: DK RL.

Methodology: DK RL.

Project administration: DK JMS.

Supervision: RK TK JMS.

Visualization: DK RL.

Writing – original draft: DK RL.

Writing – review & editing: RK TK JMS.

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Longitudinal changes and determinants of parental willingness to pay for the prevention of childhood overweight and obesity

Romy Lauer[1*], Meike Traub[1,2], Sylvia Hansen[3], Reinhold Kilian[4], Jürgen Michael Steinacker[1] and Dorothea Kesztyüs[1,5]

Abstract

Background: Willingness to Pay (WTP) is an alternative to measure quality-adjusted life years for cost-effectiveness analyses. The aim was to evaluate longitudinal changes and determinants of parental WTP for the prevention of childhood overweight and obesity.

Methods: Longitudinal data from post- (T2) and follow-up (T3) measurements of a school-based health promotion program in Germany. Parental questionnaires included general WTP and the corresponding amount to reduce incidental childhood overweight and obesity by half. Longitudinal differences were examined with the McNemar test for general WTP and the Wilcoxon signed-rank test for the amount of WTP. Regression analyses were conducted to detect determinants.

Results: General parental WTP significantly decreased from 48.9% to 35.8% ($p < 0.001$, $n = 760$). Logistic regression analysis ($n = 561$) showed that parents with a tertiary education level and a positive general WTP at T2, families with a higher monthly household income, and those with abdominally obese children were significant predictors of general WTP at T3. Median amount of WTP at T3 was €20.00 (mean = €27.96 ± 26.90, $n = 274$). Assuming a WTP of €0 for those who were generally not willing to pay or did not answer, resulted in a median amount of WTP at T3 of €0 (m = €8.45, sd = €19.58, $n = 906$). According to linear regression analysis WTP at T2 was the only significant predictor for the amount of WTP at T3 ($p = 0.000$, $n = 181$).

Conclusions: Despite the decline of general WTP, these results are a reflection of the public awareness of the problem and the need for action. Policy makers should recognize this and initiate sustainable public preventive strategies.

Trial registration: DRKS, DRKS00000494. Registered 25 August 2010, https://www.drks.de/drks_web/.

Keywords: Willingness to pay, Health economics, Childhood obesity, Intervention, Health promotion and prevention, Public health

* Correspondence: romy.lauer@uni-ulm.de
[1]Division of Sport and Rehabilitation Medicine, Ulm University Medical Center, Ulm, Germany
Full list of author information is available at the end of the article

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Background

Childhood overweight and obesity are a growing health problem [1] with about one in five children and adolescences being overweight or obese worldwide [2]. Pediatric overweight and obesity prevalence rates, identified using the Body Mass Index (BMI) [2], as well as abdominal obesity rates [3], defined as a Waist-to-Height-Ratio (WHtR) equal or greater than 0.5 [4], are rising. A higher weight during childhood is associated with cardiovascular disease indicators such as hypertension or metabolic syndrome [5], psychological problems such as anxiety and depression [6, 7], stigma [8] and with lower academic performance [9].

Besides these negative personal consequences, childhood overweight and obesity, and the associated physical inactivity, cause a great financial burden for society. In 2013, costs for physical inactivity were about 53.8 billion Dollar worldwide [10]. Childhood overweight and obesity are related with high pharmaceutical and medical care costs [11] as well as a high usage of healthcare services [12]. In this regard, obese and abdominally obese primary school children have a higher number of sick days and visits to a physician than non-obese children [13]. Furthermore, obese children are likely to become obese adults [14, 15] and therefore the costs are persisting -and probably increasing- into adulthood. The total lifetime costs for obese children and adolescents are estimated to be nearly €150,000 of which about €130,000 account for productivity losses [16].

A great number of preventive and health promoting interventions are aiming at physical inactivity, sedentary behavior and poor nutritional habits in order to prevent or reduce childhood overweight and obesity, but are rarely evaluated in terms of cost-effectiveness [17–19]. However, due to limited financial resources, a deliberate selection of cost-effective interventions is needed. Within cost-effectiveness analyses, Quality Adjusted Life Years (QALYs) are often used as an outcome indicator reflecting the benefit of an intervention from the perspective of the user, but are difficult to apply in the field of prevention as they focus on disease. Therefore, willingness to pay (WTP) can be used as an alternative measure reflecting the monetary value of an intervention from the perspective of the beneficiary [20].

In health economics, WTP measures individual's monetary values of a change in health status [20, 21] and is frequently estimated by contingent valuation (CV) [20, 22]. However, research on WTP for health promotion, and especially for the reduction of overweight and obesity in children, is scarce. Cawley found in his CV study among New York state residents a mean WTP of $46.41 for a 50% reduction in childhood obesity [23]. Evaluating WTP for the same reduction in childhood obesity in a cross-sectional study, Kesztyüs et al. detected a general WTP for 48.9% and a mean monthly WTP of €23.04 of parents of primary school children in south-western Germany [24]. In particular, parents of overweight and obese children were significantly more often willing to pay [24]. The present study builds upon the findings of Kesztyüs et al. [24] and uses longitudinal data to detect possible changes over time and determinants of WTP.

Aim

The aim of this study was to evaluate longitudinal changes of general WTP and the amount of WTP for a 50% reduction in the incidence of childhood overweight and obesity in parents of primary school children in the German Federal State of Baden-Württemberg and to evaluate determinants which influence parental WTP.

Methods

The Baden-Württemberg-study

The Baden-Württemberg-Study is the outcome evaluation study of the school-based health promotion program "Join the Healthy Boat", conducted in primary schools throughout the state of Baden-Württemberg in southwestern Germany, a cluster-randomized controlled intervention trial with a waitlist control group. The baseline measurement was conducted in fall 2010 (T1), the post measurement in fall 2011 (T2) and the follow-up measurement in spring 2013 (T3). For the present study, the post and follow-up measurements T2 and T3 were considered. Both the intervention and control group could implement the intervention at these stages of the study. Approval from the Ethics Committee of Ulm University was obtained. The study was registered in the German Clinical Trials Register (DRKS), Freiburg University, Germany (DRKS-ID: DRKS00000494). Detailed information about the trial is described in Dreyhaupt et al. [25].

The "Join the Healthy Boat" intervention

The aim of the ongoing "Join the Healthy Boat" intervention is to increase a healthy lifestyle in primary school children and prevent them from becoming overweight or obese. The main health topics are the promotion of physical activity and reducing the intake of sugar-sweetened beverages as well as the consumption of screen media. The intervention materials were developed for teachers and comply with the national education plan. They can be implemented in the curriculum, no extra lessons or external persona are required. Not only materials for children are available, but also materials for parents, e.g. family homework. More information concerning the intervention can be found elsewhere [25].

Data collection

Written informed consent from parents was obtained prior to data collection. Children's anthropometrics were taken by trained staff, while information about parental health and lifestyle characteristics were assessed using questionnaires and, if possible, separately for mothers and fathers. Socio-economic variables and all questions about general WTP as well as the amount of WTP were also assessed via questionnaires.

Anthropometrics

Anthropometric measurements of the children were executed by trained staff according to the International Society for the Advancement of Kinanthropometry Standards [26]. Children's weight was measured with calibrated flat scales and their height using mobile stadiometers (both by Seca® Company, Germany). The Body Mass Index (BMI) was calculated as weight in kilogram divided by height in m^2. The BMI for children was converted to BMI percentiles, controlling for age and gender using German reference data, with the 90th percentile as overweight and the 97th percentile as obese [27]. Waist circumference (WC) was measured in centimetres with a metal tape (Lufkin® Industries Inc., Texas, USA) exactly between the iliac crest and the border of the lowest rib. The mean of two WC measurements was used and if the difference between them was greater than 1 cm, a third measurement was conducted. The Waist-to-Height-Ratio (WHtR) was calculated by the quotient of WC and height in centimetres and a WHtR ≥0.5 defined as abdominal obese [28].

Self-reported data of parental weight, height, and WC were used to calculate BMI and WHtR. A BMI ≥ 25 was defined as overweight and a BMI ≥ 30 as obese due to WHO standards [29], and a WHtR ≥0.5 as abdominal obese [28].

Socioeconomic variables

The family education level was defined according to the CASMIN (Comparative Analysis of Social Mobility in Industrial Nations) classification [30] using the highest level of two parents or the level of a single parent. This was dichotomized into a tertiary vs. a secondary and primary level. Single parenthood and monthly household income was assessed, the latter categorized in low (< 2250€), middle (2250€ - 4000€), and high (≥ 4000€). Migration background was assumed if at least one parent mainly spoke a foreign language during the child's first year of life or at least one parent was born abroad.

Parental health and lifestyle characteristics

Parents were asked about their health awareness level on a four point rating scale ("very high", "high", "little", "very little") which then was dichotomized into a high and low level. Parents were asked about the importance of being thin for being attractive on a four point rating scale ("not important at all", "not important", "important", "very important"), which was dichotomized into "not important" vs. "important". Parents were also asked if they considered their child as too corpulent or too thin on a five point rating scale. The answers were dichotomized in "very corpulent" and "a bit corpulent" on the one side, and "neither/nor", "a bit thin", and "very thin" on the other side. Smoking status was dichotomized, with current smokers vs. non-smokers/ex-smokers.

Willingness to pay

WTP assesses monetary valuations of changes in health by presenting hypothetical scenarios about a certain change in health or an intervention [31, 32]. Individuals' monetary values are frequently assessed by CV which is measuring individuals' stated preference by asking them how much money they are willing to pay for the change in health or an intervention [32]. CV is a method assessing WTP in different ways, such as structured telephone interviews or mail surveys and by asking a series of questions narrowing down the bounds of the WTP (so called double-bounded model) or by using an open-ended question [23].

The part of the questionnaire on WTP began with some general information about overweight and obesity, it's prevalence and it's health care costs. Parents were asked to indicate whether they thought overweight and obesity were serious public health problems ("yes", "no"). Afterwards, they were told to imagine a preventive measure reducing the incidence of childhood overweight and obesity by half. The second question was, if they were in general willing to pay for this preventive measure (general WTP; "yes", "no"). The parents who answered "yes" were asked to indicate the amount of money they were willing to pay for this measure per month (amount of WTP). For T2, 12 answer categories were provided: 1) €1–5; 2) €6–10; 3) €11–20; 4) €21–30; 5) €31–50; 6) €51–75; 7) €76–100; 8) €101–150; 9) €151–200; 10) €201–300; 11) €301–500; 12) > than 500. For T3, an open-ended question was used. For the comparison of the amount of WTP between T2 and T3, data of T3 were converted into the categories of T2.

Participants

For the post measurement, 1829 children participated in anthropometric measurements with available data from 1593 parental questionnaires. For the follow-up measurement, 1043 children participated in anthropometric assessment and 906 parents provided questionnaires. An overview of the underlying numbers of datasets in the different stages of the study are shown in Fig. 1.

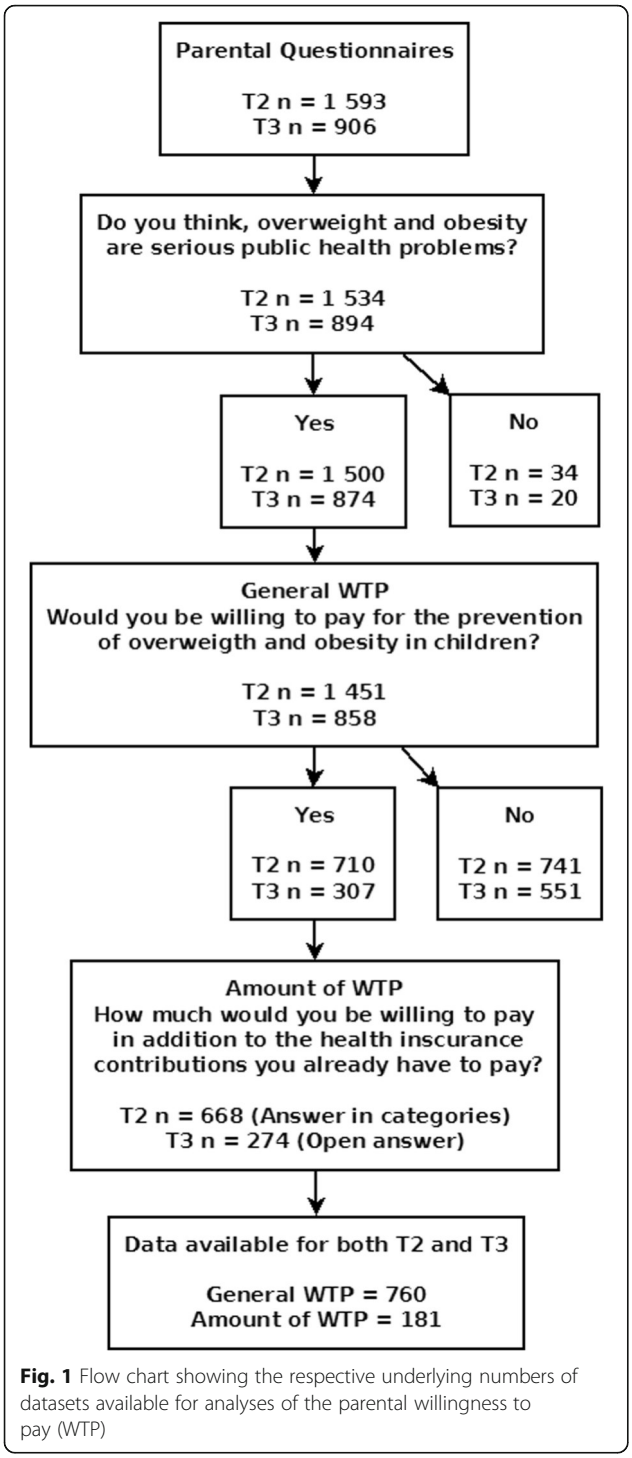

Fig. 1 Flow chart showing the respective underlying numbers of datasets available for analyses of the parental willingness to pay (WTP)

Missing data

Missing data are a commonly occurring problem in observational studies and can lead to bias [33]. Therefore, data with complete datasets were compared to those with missing data to detect possible differences.

Statistical analyses

Differences in parental and child characteristics between those parents who were in general willing to pay and those who were not willing to pay at T3 were analyzed with Fisher's exact test for categorical data and Mann-Whitney-*U* test for continuous data at T2. To analyze if parents differed significantly in their answers between T2 and T3, the McNemar test for the general WTP and the Wilcoxon signed-rank test for their amount of WTP were conducted. After calculating a generalized linear mixed model to test potential clustering of data in schools, a logistic regression analysis was executed for the general WTP at T3. As potential explanatory variables, variables assessed at T2 from Table 1 were included according to their significant association with the outcome variable and their relevance of content. For the amount of WTP, a linear regression analysis following the same strategy was conducted for parents who stated a positive general WTP. In order to investigate possible differences between participants with and without missing values for the logistic regression analyses for general WTP at T3, Fisher's exact test for categorical data and Mann-Whitney-*U* test for continuous data were calculated. To account for clustering in schools, R Release 3.2.3 for Windows (www.cran.r-project.org) was used. All remaining analyses were executed with SPSS 21 (SPSS Inc. Chicago, IL, USA). The significance level for two-sided tests was $\alpha = 0.05$.

Results

Of 894 parents at T3, 97.8% ($n = 874$) indicated overweight and obesity as serious public health problems, without significant differences for parents of overweight or obese children and the others. In the following, results for general WTP, amount of WTP and missing data are shown separately.

General willingness to pay

At T2 ($n = 1451$), 48.9% of the parents were in general willing to pay ($n = 710$). For the follow-up measurement T3, valid data from 858 parents on their general WTP were available, with 307 (35.8%) declaring their willingness to pay. Characteristics of parents and children are shown in Table 1 separately according to the parental general WTP. Given that missing values occurred and varied per item, the numbers used for the calculation of significant differences deviate from 307 respectively 551 for WTP at T3. For example, the valid cases for paternal WHtR are 307 + 551–463 = 395 (WTP yes + WTP no – missing values). In those 395 valid cases, there was no statistical significant difference concerning WTP in the percentage of fathers with a WHtR ≥0.5 (69.1% vs. 69.5%). Parents of overweight, obese and abdominally obese children, parents who considered their child as

Table 1 Participants' characteristics at T2 for the parental general willingness to pay (WTP) at T3

	Missing values n	WTP Yes *n* = 307	WTP No *n* = 551
Parental characteristics			
Age (mother), m (sd)	79	38.8 (4.9)	38.7 (4.7)
Age (father), m (sd)	118	41.7 (5.8)	41.8 (5.6)
Maternal overweight, n (%)	123	86 (33.3)	141 (29.6)
Paternal overweight, n (%)	182	139 (57.7)	260 (59.8)
Maternal obesity, n (%)	123	37 (14.3)	39 (8.2)*
Paternal obesity, n (%)	182	32 (13.3)	61 (14.0)
Maternal WHtR ≥0.5, n (%)	425	76 (50.3)	145 (51.4)
Paternal WHtR ≥0.5, n (%)	463	96 (69.1)	178 (69.5)
Considering overweight and obesity as a problem, n (%)	58	285 (99.3)	502 (97.9)
Importance of being thin for being attractive (at least one parent), n (%)	68	161 (56.9)	292 (57.6)
Considering child too corpulent (at least one parent), n (%)	39	34 (11.7)	34 (6.4)*
High level of maternal health awareness, n (%)	71	164 (59.4)	324 (63.4)
High level of paternal health awareness, n (%)	147	104 (40.6)	200 (44.0)
Smoking (mother), n (%)	59	57 (20.2)	79 (15.3)
Smoking (father), n (%)	128	68 (26.2)	129 (27.4)
Tertiary family education level, n (%)	64	110 (39.3)	153 (29.8)**
Monthly household income	168		**
< 2250€, n (%)		48 (18.9)	116 (26.6)
2250€ - < 4000€, n (%)		128 (50.4)	240 (55.0)
≥ 4000€, n (%)		78 (30.7)	80 (18.3)
Single parent, n (%)	45	32 (11.0)	60 (11.5)
General WTP yes at T2, n (%)	98	203 (75.2)	181 (36.9)***
Child characteristics			
Intervention participant, n (%)	0	154 (50.2)	305 (55.4)
Age, m (sd)	0	8.1 (0.6)	8.0 (0.6)
Boys, n (%)	0	160 (52.1)	267 (48.5)
Migration background, n (%)	73	69 (24.3)	132 (26.3)
Overweight, n (%) Kromeier	16	34 (11.2)	35 (6.5)*
Obesity, n (%) Kromeier	16	18 (5.9)	9 (1.7)**
WHtR ≥0.5, n (%) / Abdominal obesity, n (%)	16	35 (11.5)	31 (5.8)**

WHtR waist-to-height-ratio, *WTP* willingness to pay; *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

too corpulent, obese mothers, and families with a tertiary family education level and a higher household income were significantly more often willing to pay ($p < 0.05$). Parents who were in general willing to pay at T2, were significantly more often willing to pay at T3 ($p < 0.001$).

The general WTP was significantly lower at T3 (35.8%) than at T2 (48.9%), $\chi^2 = 51.49$, $p < 0.001$, $n = 760$. Details of these changes are shown in Fig. 2. Of the 760 parents with valid data, nearly three times more parents were willing to pay at T2, but not at T3 (23.8%) than the other way around (8.8%). Of the parents having the same general WTP at T2 and T3 (67.4%), 39.6% were willing to pay and 60.4% were not willing to pay at both time points.

Since there were no differences between a generalized linear mixed model and an ordinary logistic model, the

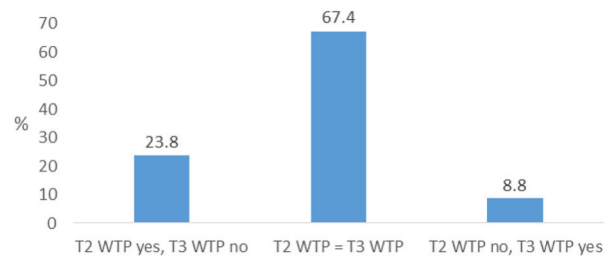

Fig. 2 Changes in general willingness to pay (WTP) over time ($n = 760$)

latter is reported. This logistic regression analysis for the general WTP at T3 is shown in Table 2 ($n = 561$, Nagelkerkes $R^2 = .237$). Parents with a tertiary education level and a general WTP at T2, families with a higher monthly household income, and abdominally obese children were significant predictors of general WTP. Maternal obesity and children with migration background were no significant predictors, but remained in the model because they were significant in Table 1 respectively relevant factors in other studies. No significant results for intervention participants were found, therefore this variable was excluded from the regression analyses.

Amount of willingness to pay

The amount of WTP at T2 had a median of the answer category 3 (11–20€) and an adjusted mean of €23.04 (99% CI [22.45, 23.75], $n = 710$). Assuming a WTP of €0 for those who did not respond and those who were not willing to pay in general, a mean of €10.27 ($n = 1593$) was given [24].

Figure 3 shows the amount of WTP per month at T3. Of the parents who were in general willing to pay ($n = 307$, 35.8%), 89.25% ($n = 274$) stated their amount of WTP with a median of €20.00 (m = €27.96, sd = €26.90). Assuming a WTP of €0 for those who did not answer the question or those who were not willing to pay in general, the amount of WTP with a median of €0 (m = €8.45, sd = €19.58, $n = 906$) was given.

The distribution of the amount of WTP differed significantly between T2 and T3 for parents who were in general willing to pay and for whom data for the amount of WTP of both T2 and T3 were available (z = – 2.133, $p = .033$, $n = 181$). The changes in WTP between T2 and T3 are visualized in Fig. 4, with nearly double the number of parents indicating a lower amount of WTP at T3 than at T2 (46.4%) than the other way around (23.8%). Nonetheless, the mean amount of WTP at T3 was higher than at T2 (mean = €27.96, 99% CI [23.74; 32.17], $n = 274$ vs. €23.04, 99% CI [22.45, 23.75], $n = 710$).

Table 2 Adjusted Odds ratios (OR) for the general willingness to pay (WTP) at T3

n = 561	OR	*p*-value	95% CI
Maternal obesity	1.84	0.060	0.98–3.48
Tertiary education level	1.53	0.049	1.00–2.34
Monthly household income			
< 2250€		*Reference*	
2250€ - < 4000€	1.26	0.396	0.74–2.14
≥ 4000€	1.93	0.042	1.03–3.63
General WTP at T2	4.80	< 0.001	3.21–7.19
Abdominal obesity child	3.92	< 0.001	1.78–8.66
Migration	0.69	0.105	0.44–1.08

CI confidence interval, *OR* odds ratio, *WTP* willingness to pay; $R^2 = .237$ (Nagelkerke)

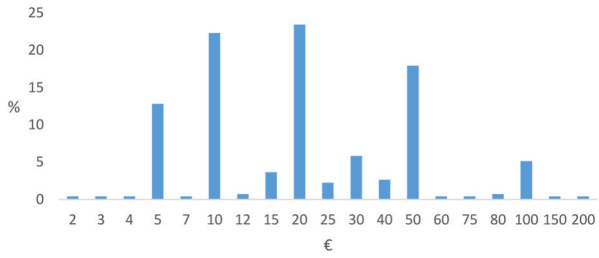

Fig. 3 Distribution of the amount of willingness to pay (WTP) per month at T3 ($n = 274$)

The linear regression analyses for the amount of WTP ($n = 181$) showed significant results only for the amount of WTP at T2 ($p < 0.001$; CI 2.58–6.89, $R^2 = .095$), increasing the average amount of WTP by €4.74. No other variables were found to be significant predictors of the amount of WTP.

Missing data

Participating children with missing data were significantly more likely to have a migration background and mothers who were smokers ($p < 0.01$); additionally, parents were significantly more often younger ($p < 0.01$) and also more frequently single parents ($p < 0.001$). Families with missing data had significantly lower monthly household incomes ($p < 0.001$).

Discussion

To end childhood obesity, the WHO demands a holistic approach where policies across different sectors address health systematically [34]. Beneficial effects of early childhood interventions occur on health and economical levels and can have an influence on the entire family, even years after an intervention [19]. The need for interventions to reduce childhood overweight and obesity requires an assessment of their cost-effectiveness in order to make allocative decisions on which interventions should be promoted. To compare the costs of preventive and health promoting strategies, WTP is a suitable alternative to QALY. However, WTP studies are scarce and, to the authors' knowledge, no longitudinal WTP study

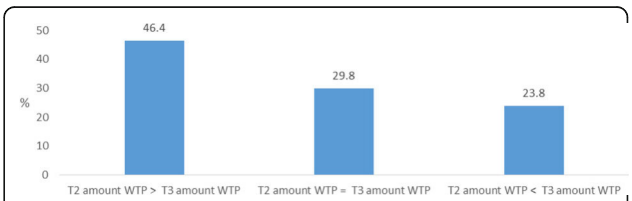

Fig. 4 Changes in amount of willingness to pay (WTP) over time ($n = 181$)

has been carried out for the prevention of childhood obesity before. Therefore, the present study assessed longitudinal changes of general WTP and amount of WTP for a 50% reduction of the incidence of childhood overweight and obesity in parents of primary school children, and also evaluated determinants of WTP.

In the present study, nearly all parents indicated overweight and obesity as serious public health problems, with higher (but not significantly) rates for parents who were in general willing to pay. This implies great awareness of the problem. Cawley [23] found, in almost all of his assessed surveys on childhood obesity, that at least two-third of the respondents indicated childhood obesity as a major problem which was associated with a higher WTP. In addition, the German public has been found to express great support for the prevention of obesity [35].

The general WTP decreased over time, with about every second parent in general willing to pay at T2 but only about every third parent at T3. Reasons for the fact that more than half of the parents were not willing to pay in general and the decrease of the general WTP, could be the German health insurance system in which almost every citizen is insured and the prospect of the "Prevention Strengthening Act", a government law on prevention efforts, which was implemented in 2015 after a long negotiation period. In this regard, parents might take public services for granted and see no need to pay for them themselves. Additionally, parents' risk assessment of their children to be overweight or obese in adulthood may be skewed by optimism, as they rate their own child's risk much lower than that of a typical child [36]. Also, parents could see obesity prevention as a task of the school, e.g. after-school physical education classes. Furthermore, at T3 the children's change to a secondary school is in sight, which sets the course for further education and employment. Therefore, parents may focus more on school achievements rather than on health subjects.

In parallel to the decreasing of general WTP, a substantial part of parents reduced the amount of their WTP at T3. Narbro and Sjöström argued a WTP of €0 might be a possible protest answer because Swedish participants might not be willing to pay extra money for a treatment that might already be covered by compulsory taxes [37]. However, in contrary to the reductions in the amount of WTP by many parents, the mean amount at T3 with €27.96 was higher than that of T2 with €23.04. Probably those who increased their amount, despite being fewer than those who decreased their amount, must have overcompensated the losses. Different measurement methods could also bias these results.

The mean WTP at T3 of €27.96 per month (€335.52 per year) of the parents who were willing to pay is much higher than the costs for this specific intervention with €24.05 per child per year [38]. Even when considering the average WTP of €8.45 per month (€101.40 per year), assuming a WTP of €0 for parents who were not willing to pay in general or those who didn't specify an amount of WTP, the WTP exceeded the costs by far.

The scarcity of comparable research of WTP for the reduction of childhood overweight and obesity exacerbates the comparability of the present findings. To the authors knowledge, only one study conducted similar research and reported a WTP of $46.41 per year which outreaches the savings from a 50% reduction of childhood overweight and obesity by far [23]. Furthermore, three studies are known for measuring WTP for obesity reduction in adults in terms of efficacy. Fu et al. [39] reported a WTP for a therapy reducing weight by 5kg in 3 months of $362, while Doyle et al. [40] detected a WTP for obesity pharmacotherapy of $10.49 per month per %-point of weight loss. Narbro and Sjöström [37] assessed a WTP of $3.280 for effective obesity treatment and even reported that participants were willing to borrow money to cover their WTP as it was about twice their monthly income. Other studies found a WTP for a 50% reduction of childhood asthma on household level between $56.48 and $64.84 [41] and a WTP for children's oral health of €37 per month [42].

Determinants of willingness to pay

Despite the smaller sample size and marginal differences compared to the cross-sectional data of the parental general WTP [24], the present study shows similar tendencies for determinants of general WTP such as maternal obesity, child's abdominal obesity and monthly household income.

All of the cross-sectional detected correlates of the amount of WTP [24], except the amount of WTP at T2, were no longer influencing factors at T3. The stability of the WTP amount at T2 supports the idea that the amount of WTP is a fairly stable construct that is not arbitrary and will persist over time.

Several studies support the present findings that families affected by overweight and obesity have a higher WTP. In their studies on obesity prevention and treatment, Fu et al. [39] and Narbro and Sjöström [37] found higher weight to be associated with higher WTP. A higher WTP for participants with a history of the disease was also found in childhood caries prevention studies [42], individual health care costs of older adults [43], and diagnostic technologies mostly for cancer [44]. Therefore, it can be assumed that affected parents are aware of the problems associated with childhood overweight and obesity and take this problem more seriously than their unaffected counterparts.

Studies also confirm the present findings that parents with a higher socio-economic status have a higher WTP. Three studies on the prevention and treatment of obesity found a higher WTP in participants with higher incomes [23] or higher incomes and higher educational levels [37, 39]. In their study on WTP for personalized nutrition Fischer et al. [45] found that a higher income was associated with a higher WTP. Higher income and higher educational level was associated with a higher WTP for childhood caries prevention [42] and for diagnostic technologies for mostly cancer [44]. This is plausible as a high education level seems to be linked to knowledge and awareness of health issues and the availability of money seems to be related to a greater investment capacity.

Strengths and limitations

The first strength of the present study is its large sample size. The large number of participants and collected data allows to control for several co-variables. Second, data collection in the entire third largest federal state with the third highest population density in Germany provides data for different living conditions of different family constellations. Third, children's anthropometrics were assessed by trained staff according to standardized protocols. Fourth, to the authors' knowledge, this is the first study to investigate longitudinal changes in parental WTP for the reduction of childhood overweight and obesity and therefore presents important results. Fifth, the CV method used for the present study has a face validity with a precise description and detailed information to enable participants to make an informed decision [46]. Lastly, pre-tests assured appropriateness of the provided information of the WTP questions and participants' understanding of the context and therefore minimize bias [21, 46].

However, some limitations have to be mentioned when interpreting the results. First, the present study was carried out primarily as an effectiveness study with the WTP study piggybacked. For organizational reasons, questionnaire surveys were carried out. If the study would have been conducted for health economic purposes only, direct interviews with a double-bounded model would have been recommended [21, 23]. Second, WTP is a hypothetical construct and therefore the assessed WTP can deviate from the real WTP [20, 39]. Because no real financial implications for the participants exist [47], they may misjudge the scenario provided and may overestimate their WTP [42] or their risk [47]. To limit this bias, pre-tests were executed. Additionally, other researchers question the importance of hypothetical bias [48]. Third, two different measurements of the amount of WTP were used (open vs. closed answers), which makes a comparison more complicated and could be the reason for conflicting findings. It is not clear which elicitation method provides most accurate estimate of the WTP [44] and therefore, two measurements were executed to evaluate their advantages and appropriateness for the present study. For the closed-ended payment scales range bias [21], framing effects [49] and bias due to the design of the payment scales can occur [50]. A higher mean WTP was found for a scale providing up to £1000 in comparison to one providing up to £100 [51] and for asking monthly WTP in comparison to yearly WTP [49]. On the other hand, open-ended questions tend to be more imprecise due to a great variation in results [31] and the prominence effect may bias results as respondents tend to provide prominent numbers such as 1, 2, 5, 10, 20, 50 etc. [52]. Fourth, selection and sampling bias may affect the results [21]. Parents are not representative for the entire population, they may tend to be more interested in the subject and more willing to pay than people without children or with children at a different age. However, even if the amount of WTP is overestimated, it is presumably still higher than the costs of the intervention, which is more than four times higher [38]. Finally, the missing data in the present study can be seen as selection bias and are a common problem in epidemiological studies. However, except for the household income, no significant differences in the WTP for those with missing values compared to those with complete data were found.

Conclusions

Nearly all participating parents rated childhood overweight and obesity as a serious public health problem. Between half and one third of the parents were in general willing to pay for the prevention of childhood overweight and obesity. Families affected by overweight and obesity and those with a higher socioeconomic status were more often willing to pay. The amount of WTP exceeded the costs of the preventive program by far. In sum, despite the decline in general WTP, these are all reflections of the public awareness of the problem and the need for action. Policy makers should be aware of this and translate it into public preventive strategies. Preferably, health promotion and obesity prevention should be sustainable and therefore integrated into the curriculum of school children and even into teacher training. This would be in line with requirements of the WHO asking for a whole-of government approach and the "health-in-all-policies".

Abbreviations

BMI: Body mass index; CASMIN: Comparative analysis of social mobility in industrial nations; CV: Contingent valuation; DRKS: German clinical trials register; OR: Odds ratio; QALY: Quality adjusted life years; WC: Waist

circumference; WHtR: Waist-to-height-ratio; WHO: World Health Organization; WTP: Willingness to pay

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Authors' contributions
DK and other members of the research group planned and organized the Baden-Württemberg study, and were involved in carrying out the measurements. RL and DK performed the statistical analyses. JMS is the director of the program "Join the Healthy Boat–primary school" and principal investigator of the Baden-Württemberg Study. RL and DK drafted the manuscript. MT, SH, RK and JMS revised the manuscript drafts. All authors have read and approved the final version of the manuscript.

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Availability of data and materials
The datasets generated and analysed during the current study are not publicly available due to data protection but are available from the Institute of Epidemiology and Medical Biometry, Ulm University, on reasonable request.

Ethics approval and consent to participate
Approval from the Ethics Committee of Ulm University was obtained. The study was registered in the German Clinical Trials Register (DRKS), Freiburg University, Germany (DRKS-ID: DRKS00000494). Written informed consent was obtained from parents and teachers.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Division of Sport and Rehabilitation Medicine, Ulm University Medical Center, Ulm, Germany. [2]Department of University Sports / Workplace Health Management, Ulm University, Ulm, Germany. [3]Ceres - Cologne Center for Ethics, Rights, Economics, and Social Sciences of Health, Unversity of Cologne, Cologne, Germany. [4]Section Health Economics and Health Services Research, Department of Psychiatry II, Ulm University Medical Center, Günzburg, Germany. [5]Institute of General Practice, Ulm University Medical Center, Ulm, Germany.

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