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Effectiveness of interventions to improve lifestyle behaviors among socially disadvantaged children in Europe

Anne I. Wijtzes[1], Vivian M. van de Gaar[1], Amy van Grieken[1], Marlou L.A. de Kroon[1], Johan P. Mackenbach[1], Frank J. van Lenthe[1], Wilma Jansen[1,2], Hein Raat[1]

1 Department of Public Health, Erasmus University Medical Center, Rotterdam, The Netherlands
2 Department of Social Development, City of Rotterdam, The Netherlands, Rotterdam

Correspondence: Anne Wijtzes, PhD, Department of Public Health, Erasmus MC, University Medical Center, Rotterdam, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands, Tel: +31 10 7043405, Fax: +31 10 7044645; e-mail: a.wijtzes@erasmusmc.nl

Background: Unhealthy lifestyle behaviors and childhood overweight are more common among children from families with a low socioeconomic position and ethnic minority children (referred to as social disadvantaged children). **Aims**: This systematic review evaluates the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among socially disadvantaged children in Europe. **Methods**: Six major databases were searched for studies reporting intervention effects on adiposity measures, sedentary behaviours, physical activity behaviours or dietary behaviours. Studies were included when the study sample consisted of at least 50% socially disadvantaged children or when results were presented for subgroups of socially disadvantaged children separately. Methodological quality assessment was based on Cochrane criteria. **Results:** In total, 11 studies reporting on eight interventions (one among infants 0–2 years, one among pre-schoolers 2–6 years, six among school-aged children 6–12 years) were identified. Of these eight interventions, five interventions primarily aimed to improve at least one adiposity measure and three primarily aimed to improve a specific lifestyle behaviour. In general, modest positive effects were found but interventions were limited by a short follow-up duration. **Conclusions:** Despite an urgent need for effective interventions to improve lifestyle behaviours and prevent overweight among socially disadvantaged children, research on the effectiveness of interventions in Europe is still scarce. Those interventions that have been evaluated show modest effects on lifestyle behaviours and adiposity measures, but long-term follow-up is needed to establish whether these effects are sustained over a longer period of time.

Introduction

Over the past three decades, childhood overweight has become a major public health concern.[1] In addition to an increased risk of overweight and obesity in adulthood,[2] childhood overweight has been associated with adverse health outcomes during childhood, including (amongst others) type 2 diabetes, asthma, skeletomuscular difficulties and psychosocial problems.[2,3] Within developed countries, childhood overweight is strongly socially patterned, disproportionally affecting children from low family socioeconomic position (SEP) and ethnic minority children (hereafter together referred to as socially disadvantaged children).[4,5]

Although the etiology of overweight is multifactorial, involving both environmental and non-environmental (i.e. genetic) factors, there is general consensus that adverse changes in lifestyle behaviours have been a major determinant of the overweight epidemic.[6] This premise has been substantiated by a wealth of observational research, showing both cross-sectional and longitudinal associations between lifestyle behaviours and childhood overweight.[6–8] Furthermore, interventions targeting these lifestyle behaviours have been shown to have modest effects on adiposity measures.[9,10] There is evidence to suggest that lifestyle behaviours are established in early childhood[11] and track into adolescence and young adulthood,[12] warranting preventive efforts in early childhood.

Studies on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among socially disadvantaged children are scarce and have mainly been conducted in the USA and Oceania.[9,10,13] Given differences in cultural and immigration backgrounds, findings of these studies cannot be generalized to European populations of socially disadvantaged children. Furthermore, US interventions among ethnic minority groups are usually performed in one specific ethnic group (e.g. African American or Hispanic children),[9,10,13] while European ethnic minority populations are often more diverse. Therefore, the aim of this systematic review is to synthesize the evidence on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among young socially disadvantaged children (0- to 12-year-olds) in Europe.

Methods

Literature search

A systematic literature search was conducted in PubMed, EMBASE, Web of Science, Medline (OvidSP), Google Scholar and Cochrane Database of Systematic Reviews in November 2013. The complete search strategies can be found in Supplementary Materials S1. The search strategy was initially designed for PubMed and subsequently adapted for all other databases. Furthermore, references of manuscripts were searched for additional studies not identified by the original search strategy. A search update was performed in April 2016.

Inclusion criteria

To be eligible for inclusion, studies had to be published in an English spoken peer-reviewed journal after 31 December 1989. Studies were included when they reported on at least one of the following variables as 'primary outcome measure': adiposity measures [i.e. body mass index (BMI), weight status, waist circumference, skin fold thickness, percentage body fat], sedentary behaviours (i.e. screen time), physical activity behaviours [i.e. habitual physical activity (low, moderate and vigorous physical activity/daily steps), sports participation] or dietary behaviours [i.e. consumption of sugar sweetened beverages (SSBs), breakfast consumption]. These specific behaviours were selected based on systematic reviews showing substantial evidence of an association with childhood overweight.[6,14] Two types of studies were included in this review on the basis of presenting intervention effects for socially disadvantaged children: (i) studies with a study sample of at least 50% socially disadvantaged children,[15] or (ii) studies reporting subgroup results for socially disadvantaged children separately. Socially disadvantaged children were defined as children with a non-native ethnic background/immigrant status or children from families with a low SEP (i.e. low parental educational level, low household income, low parental occupational class, or living in low income/deprived areas).[16] Inclusion was restricted to studies among infants (0- to 2-year-olds), preschool children (2- to 6-year-olds) and primary school children (6- to 12-year-olds) in Europe. Inclusion was furthermore limited to studies with a rigorous study design, i.e. (randomized) controlled trials with a concurrent control group.

Exclusion criteria

Studies among secondary school children/adolescents (i.e. age > 12.0 years) were excluded. In case of studies conducted among a combination of primary and secondary school children (e.g. 7- to 14-year-old children), exclusion was based on the mean age of the population. Studies without a rigorous study design, e.g. post-measurements only, pre- and post-test measurements without a proper control group, or observational studies, were excluded. Furthermore, intervention studies performed in laboratory settings, intervention studies performed among overweight/obese children only (i.e. 'treatment interventions'), and studies not reporting intervention effects for socially disadvantaged children were excluded.

Selection process

Titles and abstracts were independently reviewed by two authors (AW en VvdG) to make the initial selection of relevant intervention studies. Then, reference lists were screened for other potentially relevant studies. All studies identified between the two reviewers were reviewed using full text by both reviewers (AW and VvdG) and in the case of discrepant findings, a third party (HR) was consulted until consensus was achieved.

Results

Search results

The original search strategy identified 6080 unique studies. After the selection process based on the formulated inclusion and exclusion criteria, six studies were eligible for inclusion in this review. Even though some studies could be excluded based on multiple exclusion criteria, a study is attributed one exclusion criterion only (top to bottom), thus adding up to hundred percent (figure 1). The updated search identified an additional five studies. In total, 11 studies evaluating eight interventions were included in this systematic review.

Interventions

A description of the studies is presented in Table 1. Most interventions aimed primarily to improve adiposity measures,[17–23] with a minority primarily aiming to promote physical activity[24–26]or reduce consumption of SSBs.[27] All but one[21] of the interventions was based in the school setting, one targeting preschool children[18,23] and all others targeting primary school children.[17,19,20,22,24–27] More detailed information on the content of these interventions can be found in Supplementary Table S1. Although process evaluation of the included studies is outside the scope of this review, methodological quality of the included studies was assessed according to Cochrane criteria (Supplementary Tables S2–S4).[28]

Intervention effectiveness

An overview of intervention effects can be found in Table 2. In sum, all interventions targeting multiple lifestyle behaviours had a positive effect on at least one adiposity measure (Table 2, Supplementary Table S1).[17–21, 23] In contrast, those interventions targeting one specific lifestyle behaviour were effective only in changing that behaviour (i.e. water consumption,[22] physical activity,[24,26] consumption of SSBs[27]), and had no effect[22,24] or an adverse effect[27] on adiposity measures. An exception to this general notion is the physical activity intervention by Eyre et al.,[25] which resulted in increases in physical activity levels and decreases in percentage body fat and waist circumference. Furthermore, no spill-over effects on other lifestyle behaviours were observed for these interventions.[22,26,27]

Discussion

This systematic review aimed to synthesize the evidence on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among 0- to 12-year-old socially disadvantaged children in Europe. The search yielded a limited number of studies, especially among children under the age of 6 years. In general, interventions targeting multiple lifestyle behaviours were moderately effective in positively influencing at least one adiposity measure, while interventions targeting one specific behaviour were moderately effective in changing that behaviour but not adiposity measures.

Intervention effectiveness

Those interventions targeting multiple lifestyle behaviours and individual level determinants, family-level determinants, and environmental determinants thereof were shown to positively influence adiposity measures. These findings are plausible given the complex etiology of childhood overweight involving risk factors from all domains ranging from the most proximal lifestyle behaviours to wider environmental and societal determinants.[1,9,10,16] Notably, one of these interventions seemed to positively affect adiposity measures only in girls and not boys, possibly due to differential adherence to specific intervention components. In a similar vein, another intervention seemed to positively affect adiposity measures in younger children but not in older children. More research into potential gender and age differences in intervention effectiveness among socially disadvantaged children is merited.

In contrast, those interventions targeting specific lifestyle behaviours were effective in changing those lifestyle behaviours but not adiposity measures or related lifestyle behaviours. These results can be used to inform intervention designers that they should not, be default, rely on assumed spill-over effects (e.g. effect of a physical activity intervention on screen time or effect of a water consumption intervention on soft drinks) but rather should target the behaviours that they aim to improve.

Evidence suggests that cultural adaptation has the potential to enhance intervention relevance, effectiveness, and feasibility of

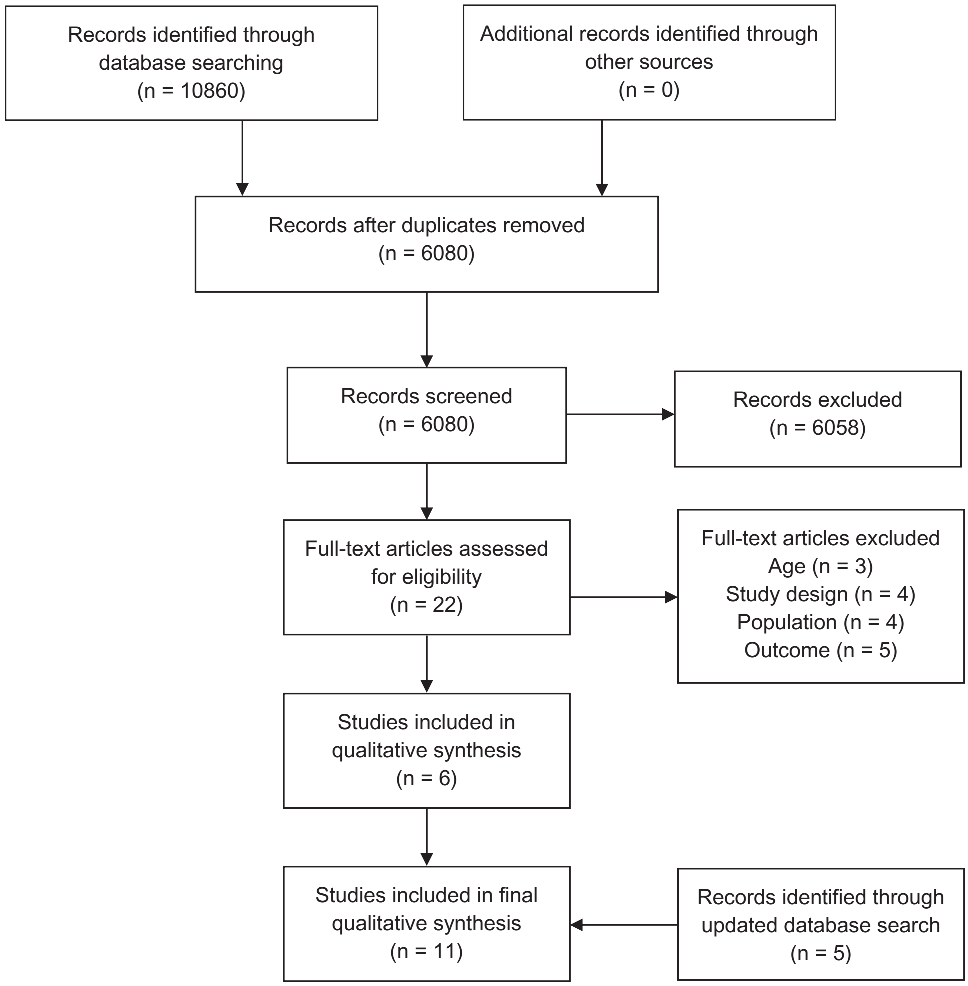

Figure 1 Flow chart of selection process

interventions for ethnic minority groups especially.[29] Indeed, substantial positive effects of those interventions with cultural tailoring (Supplementary Table S1) offer support to the premise that cultural tailoring may an important element of effective interventions for socially disadvantaged children. However, the observation that more environment-focused interventions without any apparent cultural tailoring also positively affected children's lifestyle behaviours and/or adiposity measures supports research showing that interventions in low socioeconomic groups will be most effective when structural barriers constraining healthy choices are removed.[30]

Methodological considerations

Some methodological considerations should be taken into account when interpreting the effectiveness of the interventions included in this review. Studies reporting effect estimates for subgroups were not initially designed for testing interaction effects and conducting subgroup analyses, and therefore may lack power to detect significant effects in subgroups. Similarly, feasibility studies included in this review may not have been powered sufficiently to examine intervention outcomes. Furthermore, effect evaluations were generally performed immediately post intervention, thus precluding any conclusions regarding long-term intervention effects. Although process evaluation of included studies was outside the scope of this review, an assessment of the quality of included studies was performed (Supplementary Tables S2–S4). In general, studies included in this review scored low risk or unclear risk on most criteria. The most common limitations included lack of blinding of participants (often not possible due to nature of interventions) and the use of questionnaires in the assessment of lifestyle behaviours, which together may have led to socially desirable answering.[31]

Research gaps

Based on this systematic review, a number of research gaps can be identified. First and foremost, we found that the number of studies investigating the effectiveness of interventions aimed to improve lifestyle behaviours and/or adiposity measures among socially disadvantaged children in Europe is still scarce, especially among young children (i.e. <6 years). Based on current evidence that very young children already display unhealthy lifestyle behaviours such as high screen time and consumption of SSBs,[32,33] intervening at a young age seems paramount. Furthermore, included studies were limited to Northern and Western Europe and thus indicate a need for more research in Southern and Eastern European countries where social inequalities in lifestyle behaviours and overweight also exist.[4,34,35] Third, with the exception of one community based intervention, all interventions were conducted in the (pre)school setting, hampering conclusions regarding differential effects according to intervention setting. The school setting offers major advantages that may be especially important for socially disadvantaged children,[18,24] including easily implemented changes in the school without need for parental involvement or motivation, the mandatory character of interventions elements (e.g. school curriculum changes and changes in the environment), and a large reach across all social groups. However, prevention in early childhood also requires interventions outside the school setting. Furthermore, previous research has shown that the

Table 1 Description of included studies ($n = 11$)

Study	Study population	Setting	Study design	n^{a}	Age[b]
McEachan et al. (2016)[21]	Overweight and obese pregnant women. 71% non-white British. 63% < degree level. Bradford, UK.	Community	RCT	120	−14 weeks
Puder et al. (2011)[23]	Predominantly migrant preschool children of multicultural origin. 72% migrant children. 38% children of families with a low educational level. Switzerland.	Preschool	RCT	652	5.2 years
Burgi et al. (2012)[18c]	Predominantly migrant preschool children of multicultural origin. 72% migrant children. 38% children of families with a low educational level. Switzerland.	Preschool	RCT	652 (472, 213)	5.2 years
Adab et al. (2014)[17]	Primary school children. 86% South Asian background. Birmingham, UK.	School	CT	574	6.5 years
Cezard et al. (2016)[19]	Primary school children. 86% South Asian background. Birmingham, UK.	School	CT	466	6.5 years
Jansen et al. (2011)[20]	Primary school children in more deprived inner-city areas. Primarily non-native Dutch children. Rotterdam, the Netherlands.	School	RCT	2622	6–12 years
Muckelbauer et al. (2010)[22c]	Primary school children from low socioeconomic districts. 44% immigrant children. Germany.	School	CT	3190 (1407)	8.3 years
de Meij et al. (2011)[24c]	Primary school children in socially and economically deprived areas. 85% non-native Dutch children. Amsterdam, the Netherlands.	School	CT	2848 (872, 529)	8.6 years
van Stralen et al. (2012)[26]	Primary school children in socially and economically deprived areas. 87% non-native Dutch children. Amsterdam, the Netherlands.	School	CT	600	9.8 years
van de Gaar et al. (2014)[27]	Primary school children in multi-ethnic, socially more deprived neighbourhoods. Primarily non-native Dutch children. Rotterdam, the Netherlands.	School	RCT	1175	6–12 years
Eyre et al. (2016)[25]	Deprived primary school children. 100% South Asian children. Coventry, UK.	School	CT	134	9–11 years

RCT, randomized controlled trial; CT, controlled trial.
[a]Sample size at baseline.
[b]Age at baseline.
[c]Number in bracket for study sample is the number of immigrant/low SEP children.

effectiveness of school-based interventions can be substantially improved by incorporating family and community components.[36,37] Fourth, this review identified only one intervention that primarily aimed to reduce SSB consumption and no studies that primarily aimed to reduce screen time. This finding is surprising given that SSB consumption and screen time, television viewing in particular, are two major risk factors of childhood overweight[6,7] that are more common among socially disadvantaged children.[38,39] Finally, long-term follow up of interventions is needed to confirm whether positive intervention effects are sustained over a long period of time.

Review strengths and limitations

The main strength of this review is the extensive systematic literature search performed in multiple databases. A number of limitations should be considered when interpreting our results. This systematic review relied on studies published in English spoken, peer-reviewed journals in the past 25 years. As a consequence, studies published in other languages and/or published before 1990 have not been included in this review. Perhaps even more important, publication bias favoring studies showing significant intervention effects over studies showing no interventions effects may have biased the results. Socially disadvantaged children were defined as ethnic minority children and low SEP children. It should be acknowledged that although highly related, ethnic background and family SEP are different socio-demographic characteristics likely to moderate the associations of risk factors with children's lifestyle behaviours and adiposity measures. Furthermore, studies were included only when the study sample consisted of at least 50% socially disadvantaged children to ensure that the study results would be informative for socially disadvantaged children. Albeit this cut-off point was used to reach uniformity in study inclusion and based on previous research,[15] the cut-off point itself is arbitrary and may have led to exclusion of potentially informative studies (e.g. non-stratified results by Muckelbauer et al.[40]). Process evaluation and evaluation of the effectiveness of secondary prevention interventions, or so called 'treatment' interventions, were outside the scope of the current review, precluding any conclusions regarding important process variables (e.g. intervention reach and sustainable implementation) and recommendations on how best to 'treat' childhood overweight among socially disadvantaged children in Europe. Also outside the scope of this review was the assessment of the effect of interventions on reducing social inequalities in children's lifestyle behaviours and adiposity. When implementing an intervention in the general population that is more effective among non-socially disadvantaged children compared with socially disadvantaged children, social inequalities may increase even when socially disadvantaged children benefit from the intervention.[41] This systematic review was limited to studies employing rigorous study designs, i.e. (randomized) controlled trials with a concurrent control group. As a consequence, broader policies that may be especially effective in improving lifestyle behaviours and adiposity among socially disadvantaged children (e.g. tax policies, policies to ban unhealthy-food advertisement, policies for changing the built environment)[30] and that are difficult to assess by (randomized) controlled trials[30,41] were excluded from this review. Finally, meta-analysis of the results was not possible due to the heterogeneity in study populations, interventions, outcome measures and statistical analyses.

Conclusion

Given the high prevalence of unhealthy lifestyle behaviours and childhood overweight among socially disadvantaged children in Europe, preventive interventions are highly warranted. This systematic review shows that 'although the relevant evidence base is involving, it is not keeping pace with the need for solutions' (p. 178).[15] Those interventions that have been evaluated show

Table 2 Intervention effects of included studies (n = 11)

Study	Anthropometrics	Physical activity behaviours	Sedentary behaviours	Dietary behaviours
McEachan et al. [21a]	(P) Weight SDS: −0.25 (−0.65, 0.16) (S) Conditional weight gain > 1 centile band: **0.29 (0.10, 0.85)** (S) Conditional weight gain > 2 centile bands: 0.38 (0.10, 1.49) (S) Weight >85th centile at 12 months: 0.50 (0.15, 1.64)			
Puder et al. [23a]	(P) BMI (kg/m^2): −0.07 (−0.19, 0.06) (S) % Overweight: 0.65 (0.32, 1.32) (S) Body fat (%): −**1.1 (**−**2.02,** −**0.20)** (S) Waist circumference (cm): −**1.0 (**−**1.6,** −**0.42)** (S) Sum of skinfolds (mm): −**2.78 (**−**4.35,** −**1.2)**	(S) Objectively measured PA (CPM): −12.3 (−51.5, 26.9)	(S) Media use (min/day): −**13.4 (**−**25.0,** −**1.7)**	
Burgi et al. [18a]	'Immigrant children' (P) BMI (kg/m^2):−0.05 (−0.18, 0.08) (S) Body fat (%): −**1.14 (**−**2.06,** −**0.22)** (S) Waist circumference (cm): −**1.02 (**−**1.69,** −**0.36)** 'Low SEP children' (P) BMI (kg/m^2): 0.04 (−0.15, 0.23) (S) Body fat (%): −0.43 (−1.63, 0.77) (S) Waist circumference (cm): −**1.10 (**−**2.0,** −**0.20)**			
Adab et al. [17a]	(P) BMI z-score: −**0.15 (**−**0.27,** −**0.03)** (S) % Obese: **0.41 (0.19, 0.89)** (S) Waist circumference (cm): −0.86 (−1.87, 0.15) (S) Sum of skinfolds (mm): −0.97 (−2.70, 0.77)	(S) Objectively measured PA (CPM): −0.18 (−0.36, 0.01)		
Cezard et al. [19b]	'Boys' (P) BMI (kg/m^2): Control group: 0.8 (0.2, 1.6) Intervention group: 0.7 (−0.0, 1.5) (S) Waist circumference (cm): Control group: 3.8 (2.3, 6.2) Intervention group: 4.0 (1.3, 6.9) (S) Skinfolds (mm): Control group: 2.9 (−2.1, 11.5) Intervention group: 2.8 (−1.3, 12.1) 'Girls' (P) BMI (kg/m^2): Control group: **1.1 (0.4, 2.4)** Intervention group: **0.6 (**−**0.6, 1.78)** (S) Waist circumference (cm): Control group: **5.3 (2.5, 9.0)** Intervention group: **3.0 (0.3, 5.8)** (S) Skinfolds (mm): Control group: 7.0 (−3.4, 17.9) Intervention group: 0.3 (−2.4, 11.5)			
Jansen et al. [20a]	'Grades 3–5' (P) BMI (kg/m^2): −0.10 (−0.22, 0.03) (P) % Overweight: **0.53 (0.36, 0.78)** (P) Waist circumference (cm): −**1.29 (**−**2.16,** −**0.42)** 'Grades 6–8' (P) BMI (kg/m^2): 0.03 (−0.12, 0.17) (P) % Overweight: 1.25 (0.79, 1.99) (P) Waist circumference (cm): −0.71 (−1.72, 0.29)			

(continued)

Table 2 Continued

Study	Anthropometrics	Physical activity behaviours	Sedentary behaviours	Dietary behaviours
Muckelbauer et al.[22a]	(P) % Overweight: 1.02 (0.63, 1.65)			(S) Consumption of water (glasses/day): **1.0 (0.6, 1.4)** (S) Consumption of soft drinks (glasses/day): −0.1 (−0.3, 0.1)
de Meij et al. [24a]	(S) BMI (kg/m^2): 0.07 (−0.02, 0.16) (S) Waist circumference (cm): 0.3 (−0.15, 0.75)	(P) Sports participation: **2.8 (2.18, 3.62)** (P) Objectively measured physical activity (CPM): 40 (−27, 106) 'Turkish children' (P) Sports participation: **3.2 (1.91, 5.21)** 'Moroccan children' (P) Sports participation: **4.2 (3.63, 5.7)**		
van Stralen et al. [26a]	(P) Sports participation: **2.68 (1.60, 4.46)**		(S) TV viewing (times/ week): 0.58 (−0.26, 1.43) (S) Computer use (times/week): 0.36 (−0.35, 1.08)	
Van de Gaar et al. [27a]	(S) BMI (kg/m^2): **0.26 (0.11, 0.40)**			'Parent report' (P) Consumption of SSB (L): −**0.19 (**−**0.28,** −**0.10)** (P) Consumption of SSB (no.): −**0.54 (**−**0.82,** −**0.26)** 'Child report' (P) Consumption of SSB (L): 0.04 (−0.10, 0.19) (P) Consumption of SSB (no.): 0.05 (−0.36, 0.47)
Eyre et al. 2016 [25c]	(S) BMI (kg/m^2): Control group: −1.94 (±0.93) Intervention group: −0.21 (±0.88) (S) Waist circumference (cm): Control group: −**0.21 (±3.49)** Intervention group: −**1.73 (±4.48)** (S) Body fat (%): Control group: −**1.09 (±2.77)** Intervention group: −**4.46 (±4.77)**	(P) Daily steps: Control group: −**1121 (±5592)** Intervention group: **8694 (±4929)**		

(P), primary outcome; (S), secondary outcome; (CPM), counts per minute; (L), liters; (no.) number of servings; Bold print indicates significance.
[a]Values represent intervention effects, i.e. differences between intervention and control group (reference group). Differences in continuous outcomes are presented by beta's (95% CI) and difference in categorical outcomes are presented by odds ratios (95% CI). Where possible, fully adjusted differences are presented.
[b]Values represent median change (1–3 quartile) from baseline to follow-up for control and intervention groups.
[c]Values represent mean change (standard deviation) from baseline to follow-up for control and intervention groups.

modest effects on adiposity measures and lifestyle behaviours, but long-term follow-up is needed to establish whether these effects are sustained over a longer period of time.

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Key Points

- Research on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among socially disadvantaged children in Europe is still scarce.
- Evaluated interventions show modest positive effects but are limited by a short follow-up duration.
- Intervention developers and policy makers will need further evidence from studies among very young children (i.e. <6 years), studies based in the home setting, and studies conducted in Southern and Eastern Europe.

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Variations in death certification practices distort international comparisons of mortality from diabetes

Inbar Zucker[1,2] and Tamar Shohat[1,2]

1 Ministry of Health, Israeli Center for Disease Control, Israel
2 Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

Correspondence: Inbar Zucker, Israeli Center for Disease Control, Ministry of health, Gertner Institute Sheba Medical Center, Tel Hashomer, 52621 Israel. Tel: +972-3-7371500, Fax: +972-3-5349881, e-mail address: inbar.zucker@moh.health.gov.il

Background: Israel is ranked second among OECD countries in diabetes mortality despite good performance on diabetes care measures. This study assessed whether variations in death certification practices could explain differences in diabetes mortality rates between countries, using a comparison between the USA and Israel as an example. **Methods**: Multiple cause mortality data for Israel and the USA were analyzed. The proportions of cases with diabetes coded as the underlying cause of death (UCOD), of all certificates with diabetes listed as one of the multiple causes of death (MCOD), were calculated by age-group, and compared between the USA and Israel, with emphasis on cases in which cardiovascular events were reported in part I of the certificate. **Results**: The diabetes UCOD/MCOD ratio was higher in Israel for all age groups. The differences in proportions were larger when cardiovascular events were reported in part I. Diabetes mortality rate ratio between the countries would be 49% lower if the UCOD/MCOD ratios in US data were applied to the Israeli data. **Conclusions**: Half of the difference in the reported diabetes mortality rate between the USA and Israel is explained by different coding practices. International comparisons could be improved by using multiple cause data or by clarifying guidelines regarding certification of diabetes deaths.

Introduction

Israel is ranked second among OECD countries in reported diabetes mortality.[1,2] Since the prevalence of diabetes in Israel is similar to the OECD average[2] this could imply a higher case fatality rate of diabetic patients in Israel. In contrast, the mortality rates in Israel from stroke and ischemic heart disease (IHD), two conditions closely related to diabetes, are among the lowest in the OECD.[1] These conflicting findings could be attributed to differences in death certification practices relating to diabetes, specifically, when and how often diabetes is reported and selected as the underlying cause of death (UCOD).

The National Center for Health Statistics in the USA developed multiple-cause coding in order to address the fact that many deaths are caused by the association of several chronic diseases. This coding of mortality data has been used in the USA since 1968.[3] Multiple-cause coding is now widely used in many countries including Israel. However, official statistics and international comparisons are still based solely on the UCOD.[4,5]

According to WHO selection rules, in cases of death from an acute disease that can be caused by diabetes (e.g. IHD, renal failure), diabetes can be reported either in part I of the death certificate, possibly as the UCOD, or in part II as a contributing cause.[6] The decision as to how to record diabetes is in the discretion of the physician who completes the death certificate, based on the medical data available to him and his clinical judgment regarding the sequence of events that led to the death. This subjective classification is the source of considerable variability between physicians as well as in mortality statistics between countries.[7,8] Previous studies demonstrated that the proportion of deaths with diabetes as the UCOD, of all deaths with diabetes as one of the multiple causes of death (MCOD) varies between countries. UCOD/MCOD was reported as 0.22 in Sweden, 0.24 in Italy, 0.3 in the USA, 0.39 in France and 0.5 in Taiwan.[7,9,10]. Furthermore, this proportion can vary with time[9,11,12] and with the characteristics of the deceased or the certifier.[13,14] One study compared certifications of causes of death of diabetic subjects by providing 220 certifying physicians from six European countries with six case histories describing death cases of diabetic patients.[15] Large variation was found in cases in which the deceased were long-time diabetes patients and died from acute cardiovascular events such as stroke or myocardial infarction.[15] A study from Sweden showed that variation in coding chronic diseases, including diabetes, as the UCOD or a MCOD may occur on a regional level within the same country.[16]

Age-adjusted diabetes mortality rates are consistently considerably higher in Israel than in the USA; in 2010 the rates were 42.4 per