Chapter 1

Promoting health and striving to reduce health inequities

Silvia Bel-Serrat, Alba M. Santaliestra-Pasías, Luis A. Moreno

1. Introduction

Health inequalities are a major worldwide concern, and this is especially relevant when considering the pediatric age group. Some research has suggested that socioeconomic differences in health emerge in early childhood and then diminish in early adolescence, only to re-emerge in adulthood (1). However, most of the evidence shows social class gradients in health at every stage of the life course. In adolescents, it has also been recently observed that socioeconomic inequality has increased in many domains. These trends coincide with unequal distribution of income between rich and poor people (2).

Childhood and adolescent obesity is one of the most important current public health concerns worldwide. Substantial socioeconomic inequalities in childhood and adolescent obesity are well documented. Associations between socioeconomic status and adiposity in children are predominately inverse (3). In the US, the prevalence of obesity amongst high-socioeconomic status adolescents has decreased in recent years, whereas the prevalence of obesity amongst their low-socioeconomic status peers has continued to increase (4). In a longitudinal study, it was observed that gains in income during early childhood promoted healthy weight outcomes amongst girls (5).

A strong socioeconomic gradient also exists for the majority of the early-life predictors of obesity, like pre-natal risk factors (pre-pregnancy maternal body mass index (BMI), diabetes and pre-pregnancy diet), ante-/peri-natal risk factors (smoking during pregnancy and low birth weight) and early-life nutrition (including breastfeeding initiation and duration, early introduction of solids, maternal and infant diet quality, and some aspects of the home food environment), and television viewing in young children (6).

The relationship between the environment and obesity is extremely complex. These can range from local factors to global determinants (7). Effective multilevel interventions should be developed to address the obesity epidemic. During the past 20-30 years, multiple controlled intervention studies have been conducted, particularly amongst children and adolescents. Comprehensive obesity-prevention programmes that target multiple energy balance-related behaviours have been shown to promote positive dietary and physical activity (PA) behaviours, although single-strategy interventions generally report limited success.

Given the difficulties to manage obesity once established, this strengthens the need for effective primary prevention strategies in children and adolescents. At least moderately strong evidence supports the effectiveness of school-based interventions for preventing childhood obesity (8).

Several systematic reviews have focused on energy-balanced related behaviours in young population groups with the aim of obesity prevention from all socioeconomic status (SES) (9, 10). For instance, Bleish et al. found in community-based childhood obesity prevention studies that a combined strategy of diet and physical activity intervention(s), including a school component, is more effective for preventing obesity or overweight (9). A recent meta-analysis showed that school-based interventions for childhood obesity prevention, combining diet and physical activity, were mildly effective in reducing BMI in children (10). Taking into consideration the socioeconomic position, Beauchamp et al. (11) recently published a systematic review on public health interventions conducted in all age-groups, i.e. young and adult populations, including also overweight/obese people. The review mainly focused on primary prevention of weight gain and concluded that those targeting the modification of individual behaviours may be less successful in lower SES individuals.

The aim of the present study is to analyze the current information about intervention studies based on energy balance-related behaviours to prevent obesity in low socioeconomic children and adolescents.

2. Social gradient and health inequities. Findings from intervention studies

Health inequities are persistent and widespread across the European region (12). They arise from inequities in the distribution of power, money and resources, and occur both

between and within countries (12). Indeed, the European region includes countries which are close to the best health and narrowest health inequities in the world given the long and sustained period of improvement which includes developed and welfare states and high-quality education and health services (12). This social, economic and health development, however, has not been fully shared by every country, and, in spite of the improvements, differences still remain and, unavoidably, health is affected (12). Therefore, health inequities are not decreasing, but even increasing in many countries, coupled with the economic crisis since 2008, which has exacerbated this trend (12). There is a *social gradient* in health where the higher the socioeconomic position/conditions of people and communities the better their health. Indeed, people in the most disadvantaged social groups and communities, who are subject to many different types of exclusionary processes, experience much worse health than those in more advantaged circumstances, implying a gradient that increases, non-linearly, with level of deprivation (12). Focusing on younger population, relative poverty in childhood strongly influences health and other outcomes throughout life and remains high in much of the European region (12).

Low- and middle-income countries tend to have higher non-communicable diseases (NCD) risk factors than high-income countries. Within the same country, similarly, NCDs and their most important risk factors are higher in people and communities with a lower socioeconomic status within the same country (13). Likewise, rates of obesity are higher in those communities with relatively low socio-economic status; for that reason, tackling inequities in overweight and obesity, and their related determinants such as diet, physical activity and sedentary behaviours, amongst others, has been a priority for European researchers and policy-makers over the last few years (14). Effective intervention programmes should be developed for primary prevention of obesity, especially focusing on children, aiming to reduce health inequities. However, only few intervention studies have been conducted in this sense and, therefore, there is scarce evidence about the effectiveness of interventions in reducing health inequities in obesity. Therefore, a systematic review was conducted to identify intervention studies reporting data on energy balance-related behaviours to prevent obesity in children and adolescents. Only studies fulfilling pre-defined specific inclusion criteria were collected and evaluated for relevance according to the aim of the systematic review. Below provides a review summary of the main findings observed by intervention studies conducted with children and adolescents from different socioeconomic status to prevent obesity outcomes. Studies are grouped based on the main component(s) addressed in the intervention.

2.1. Dietary interventions

A one-year follow up intervention study was conducted with German children (mean age 8.3±0.7 y) (15, 16) that comprised diet structured lessons and aimed to improve beverage consumption by increasing water intake via a combination of environmental and educational measures. Water fountains were also installed in the

intervention schools. The risk of overweight was reduced by 31% in the intervention group, but changes in BMI z-scores (z-BMI) did not differ between them (15). The intervention effect on the remission of overweight was significantly modified by the differences in diverse immigration backgrounds (p=0.02). During the follow-up period, overweight incidence was reduced significantly in the intervention group among the non-immigrants, but not among the immigrant background (16).

2.2. Physical activity interventions

An intervention study was carried out in Australian adolescents from disadvantaged neighbourhoods (mean age 14.3±0.6 y). The outcomes measured included BMI, percent of body fat and waist circumference. The intervention integrated a multi-component school-based intervention and included sport sessions, interactive seminars, lunch-time activities, leadership sessions and pedometers monitoring of PA. The intervention group showed a beneficial reduction effect in BMI and z-BMI compared with the control group.

2.3. Dietary and physical activity interventions

Most of the studies (17-23) that aimed to improve obesity-related outcomes combined diet and PA interventions. These studies involved various types, intensities and durations of the interventions. Assessed outcomes varied across studies: weight, z-weight, BMI, z-BMI, BMI percentiles, body fat percentage, and skinfolds thickness. Three of the seven studies showed statistically significant improvements in obesity-related outcomes (19, 20, 22). All the effective studies were targeting children.

As a further example, a two-year intervention focusing on low-income schoolchildren, consisting of modifications of school-provided meals and of increased opportunities for PA during the school day, showed that, a significantly higher proportion of children remained within the normal BMI percentile range in the intervention schools than in the control school (20). Additionally, the intervention schools were significantly more likely to reduce their BMI z-score ($p<0.01$) and their weight z-score ($p<0.05$), in comparison with children in the control schools (19).

Advice about healthy eating habits, scheduled meals and daily physical activity among children and their parents was included in a two-year intervention aimed to promote healthy lifestyle among Swedish children (mean age = 10.6±0.4 y). The results showed significantly higher BMI in the control group (adjusted mean = 28.94 kg/m^2) compared to the intervention group (adjusted mean = 28.09 kg/m^2) (22). Z-BMI at follow-up was also significantly higher in the control group compared with the intervention group.

Four studies did not find significant differences in terms of obesity-related outcomes after the intervention. (17, 18, 21, 23).

2.4. Physical activity and sedentary behaviour interventions

A tailored after-school dance and screen time intervention was implemented for one year in low-income African American children (age range: 8-10 y) (24). Assessed outcomes included BMI, waist circumference and triceps skinfolds. No changes in body composition indicators were observed between intervention group and control group, but the incidence of being overweight during the follow up period was reduced significantly in the intervention group among those from a non-immigrant background.

2.5. Dietary, physical activity and sedentary interventions

A one-year intervention study was performed in American children combining diet, physical activity and sedentary behaviours (25). Two-intervention groups were created. One group included activities to increase moderate-to-vigorous PA, physical exercise (PE) and activity breaks, fruit and vegetable consumption, and to decrease television (TV) viewing and sugar-sweetened beverage consumption. Apart from the activities included in the first intervention group, the second intervention group also included the formation of the "community action" team, which aimed to identify priority areas of action; it also implemented workshops and activities each semester, and assessed outcomes included BMI. The percentage of students classified as overweight or obese decreased by 3.1% in the first group whereas a decrease of 8.2% was observed within the second "intensive" intervention group ($p<0.005$).

2.6. Dietary, physical activity, sedentary and sleep interventions

Few studies aiming to improve obesity related outcomes included interventions that comprised four components i.e. diet, PA, sedentary behaviours and sleeping habits (26-28). Two publications belonged to the same intervention study, which was carried out predominantly in migrant preschool children from Switzerland. The follow-up period comprised of ten and twelve months, respectively. A cultural tailored intervention consisting of a PA programme and lessons on nutrition, media use and sleep was conducted. Fixed and mobile equipment were installed around classrooms. Assessed outcomes included BMI, percent body fat, waist circumference and skinfolds (triceps, biceps, subscapular and suprailiac). Although no group differences in BMI at follow-up were observed, children in the intervention group showed reductions in percentage body fat and sum of the four skinfolds, as well as lower increases in waist circumference compared with control children (26). The intervention was similarly beneficial among preschoolers of migrant parents compared to non-migrant parents. However, children of low education level parents had smaller intervention effect sizes, compared to children of middle/high education level parents, although differences did not reach statistical significance (27). Another study was conducted in the US to examine the effectiveness of a home-based intervention conducted in low-income, racial/ethnic minority families with young children (28). The intervention promoted household routines, family meals, adequate sleep, limiting TV time, and removing the TV from the child's bedroom, using

motivational coaching at home and by phone. After a 6-month intervention, the intervention group decreased their BMI compared with the control group (p=0.05).

Only a few intervention studies exclusively addressed minority groups or compared high versus low SES populations or migrant versus non-migrant populations. Furthermore, the studies' heterogeneity in terms of sample size, participants, design, type of intervention, duration of the intervention, outcomes and follow-up hindered the generalizability of the observed findings and, consequently, the evaluation of the effectiveness of the interventions across studies. Overall, it seems that interventions combining both diet and PA components could be effective to prevent children from becoming overweight in the long run.

Several recommendations can be drawn based on the results derived from the studies. The main barriers and triggers that emerged from the intervention studies carried out in minority groups were extracted in Table 1. These identified major barriers could be overcome by:

- extending intervention periods to out-of-school time, including summer programming, and controlling eating and exercise outside the school;
- enhancing parental and teacher participation, and;

Table 1. Main barriers and triggers identified through studies

Barriers

- Extended periods of out-of-school time (holidays, summer vacations)
  - Inclusion of summer programming
- Heterogeneity in immigrant background
- No control of eating and exercise habits outside the school
- Low intensity of intervention
- Low attendance to sessions combined with lack of parental participation
- Willingness of parents to lobby for a change in lifestyle
- Low levels of compliance in teachers as main intervention partakers
- Low likelihood of implementation in classroom curriculum-related interventions

Triggers

- Support of school-staff and parental (parents and siblings) involvement as key factors
  - Valuable sources for making healthy lifestyle changes.
- Daily contact maintenance with the participant population during the initial intensive phase
- Viewing of interventionists (i.e. teachers or University students) as role models by the participants
  - Increased excitement to participate in activities with them
  - Participants received consistent positive feedback for modifying their behaviours
- Family and parents involvement to support the changes within the home environment
- Consistent follow-up of school activities by study facilitators
- High level of school head support
- Change in the school environment: Importance of long-term commitment of school resources and innovations for influencing child physiological changes
  - Built environment & Curricular framework
- Importance of a long-term commitment of the community for influencing child physiological changes
- Community facilitated the post-intervention sustainability of many polices, system changes and programme elements
- Integration of community involvement through school

- controlling the intervention intensity and children's attendance, which should be carefully monitored to guarantee the success of the intervention.

On the other hand, the most important identified triggers are the following:

- school-staff and parental involvement as the key factors to motivate healthy lifestyle changes;
- changes in the school environment accompanied with the support from the school head to ensure the sustainability of the intervention and to promote child behavioural changes;
- community involvement to facilitate post-intervention sustainability;
- daily contact maintenance and participation of teachers or University students as role models to increase the interventions' effectiveness.

2.7. Levers and challenges to reduce health inequities

Reducing health inequities particularly those related with overweight, obesity and associated determinants are a priority for European research. The WHO, indeed, recommends considering reduction of health inequities as the main criteria to assess health system performance (12). The EPODE for the Promotion of Health Equity (EPHE) evaluation project aims to reduce inequalities related to childhood obesity prevention among high and low SES groups, with a special focus on the child and the family environment (14). The EPHE intervention focuses on four determinants: promotion of fruit and vegetables intake, water intake, active lifestyle and adequate sleep duration. Additionally, segmentation approaches are important to determine the intervention's effectiveness in community-based obesity prevention programmes (29).

According to Brown & Summerbell (30), the number of interventions aiming to prevent obesity during childhood, and even adolescence, has been increasing over the last few decades. This tendency is also observed when referring to studies focused on low-income population groups as all the studies reported here were conducted between 2003 and 2012; nine of the twenty-one studies identified were carried out in 2010. Interventions are mainly conducted through/in schools, i.e. kindergartens, primary schools and secondary schools, maybe because the school setting increases its ability to be implemented.

The most common approach when designing obesity prevention interventions is a combination of diet and PA, as it allows researchers to cover two major lifestyle factors influencing obesity development. In spite of that, it seems that the combination or not of several energy balance-related behaviours, i.e. diet, PA, sedentary behaviours and sleep, within the same intervention does not determine its effectiveness. Based on our findings, both the intervention that exclusively focused on PA and the intervention combining diet, PA and sedentary behaviours were effective and significantly reduced obesity outcomes (21, 25). On the other hand, focusing on a single behaviour does not ensure the success of the intervention. Only one out of two studies using a dietary intervention approach was effective in decreasing the incidence of overweight at

follow-up in children, although no changes were found in body composition indicators (15). PA interventions, however, were effective in decreasing the obesity outcomes in both children and adolescents. Combining PA and sedentary interventions does not seem to be effective given the lack of effectiveness in the specific study (24).

In agreement with Brown & Summerbell (30), the effectiveness of the interventions to prevent obesity with a combined diet and PA approach is equivocal, and this is also the case in interventions focusing on low SES. A consistent pattern between the effectiveness of the intervention and the size and duration of the study was not observed either. In fact, those studies with the longest duration of intervention, i.e. three years, were not effective in reducing obesity outcomes (17). Nine out of 15 studies were successful in reducing body fat (26) or BMI (16, 19, 22, 25, 28, 31, 32), or maintaining BMI (20) in low-income children and adolescents, whereas no significant improvements were seen in terms of obesity outcomes in the other six.

Outcome measurements differed among the studies, but the most common was BMI. Most of the studies included BMI, BMI percentile or z-BMI as their main outcome, followed by percent of body fat, which were measured in six out of eighteen studies. The majority of the studies used simple measurements to assess body composition, in order to ease and simplify the evaluation and the follow-up period. The use of different body composition indicators across studies makes the comparison of obtained results difficult. Moreover, isolating a single parameter (BMI or z-BMI change) and neglecting other important outcomes may undermine the evaluation of childhood obesity intervention effectiveness (33). According to most researchers (34), a reduction in BMI z-score of at least 0.25 is considered clinically significant for pediatric weight loss. Although none of the studies that used z-BMI as outcome observed a reduction of at least 0.25 units (22, 28, 31), there were significant differences between control and intervention groups when analysing the effect on the prevalence of overweight (16, 25, 32). These results increase the possibility to reduce the minimum changes in z-BMI to consider them as clinically meaningful, as limited changes in body composition do not exclude relevant changes in other cardiovascular risk factors such as insulin resistance or blood pressure (35, 36).

The ability of the intervention to reach low-income children and adolescents is as crucial as it is likely to determine its success. Programme adaptation, according to the population of interest, through previously conducted pilot studies and focus groups, to address racial/ethnic population-associated disparities, seems to be one factor that positively influences the effectiveness of the intervention within low-income population groups (37, 38). Offering activities for free and incentives during the interventions, could also improve the intervention's adherence, given that low-income population groups often cannot afford these types of activities. Furthermore, children from low SES families had higher likelihood of being qualified for free and/or reduced prices at school canteens, which increased the proportion of children taking advantage of such school services and, consequently, the rate of exposure to interventions developed at the school canteens. Likewise, support from school-staff, long-term commitment of schools, community resources and innovation are

essential to contribute to the child's physiological changes. In fact, implementing interventions through the school settings with teachers acting as interventionists could enhance the adherence to the intervention. This may be explained by the fact that teachers may be seen as role models, which would result in increased eagerness to participate in activities. This provides children with consistent positive feedback to modify their behaviours. For those reasons, schools may be effective environments to implement strategies to prevent obesity (19). In contrast, low levels of teachers' compliance together with low likelihood of implementation of classroom curriculum-based interventions, can negatively affect the effectiveness of interventions. For that reason, it is recommended to support and encourage teachers, in order to guarantee the success of the programme. Additionally, family involvement is a key factor for making healthy lifestyle changes and maintaining these changes within the home environment. Indeed, the lack of parental participation together with a poor willingness of parents to lobby for a change in lifestyle were considered as crucial factors in determining the success of the intervention.

On the other hand, some studies observed that extended periods of out-of-school time, i.e. holidays and summer vacations, decreased the effect of treatment over time. As proposed by Hollar et al. (19, 20), this could be ameliorated by the inclusion of additional programming during such periods. Additionally, the lack of control of habits within the home environment may be another key factor influencing the absence of significant results in the improvement of obesity outcomes. The degree of heterogeneity in migrant background could also be decisive, as it may hinder the development of tailored intervention programmes to each specific population. Therefore, the evaluation of different migrant and SES groups is a key-factor to further develop strategies for obesity prevention.

Overall, measures need to be taken to reduce inequities in the social and physical environment, e.g. access to healthy foods, walking and cycle paths, job opportunities and education, in order to reduce behavioural risk factors and other health determinants (39). It is also crucial to design policies that act across the whole gradient, address the needs of people from low SES backgrounds (12). Policy analysis and recommendations should be specific to low, middle and high-income countries and communities to reduce the existing gap and to make progress, including those with low-incomes (12).

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