Equity-Specific Effects of 26 Dutch Obesity-Related Lifestyle Interventions

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Context: Reducing health inequalities is a policy priority in many developed countries. Little is known about effective strategies to reduce inequalities in obesity and its underlying behaviors. The goal of the study was to investigate differential effectiveness of interventions aimed at obesity prevention, the promotion of physical activity or a healthy diet by SES.

Evidence acquisition: Subgroup analyses in 2010 and 2011 of 26 Dutch studies funded by The Netherlands Organization for Health Research and Development after 1990 (n=17) or identified by expert contact (n=9). Methodologic quality and differential effects were synthesized in harvest plots, subdivided by setting, age group, intensity, and time to follow-up.

Evidence synthesis: Seven lifestyle interventions were rated more effective and four less effective in groups with high SES; for 15 studies no differential effects could be demonstrated. One study in the healthcare setting showed comparable effects in both socioeconomic groups. The only mass media campaign provided modest evidence for higher effectiveness among those with high SES. Individually tailored and workplace interventions were either more effective in higher-SES groups (n=4) or no differential effects were demonstrated (n=9). School-based studies (n=7) showed mixed results. Two of six community studies provided evidence for better effectiveness in lower-SES groups; none were more effective in higher-SES groups. One high-intensity community-based study provided best evidence for higher effectiveness in low-SES groups.

Conclusions: Although for the majority of interventions aimed at obesity prevention, the promotion of physical activity, or a healthy diet, no differential effectiveness could be demonstrated, interventions may widen as well as reduce socioeconomic inequalities in these outcomes. Equity-specific subgroup analyses contribute to needed knowledge about what may work to reduce socioeconomic inequalities in obesity and underlying health behaviors.

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Context

The prevalence of obesity has increased dramatically over the past 30 years in almost all developed countries.[1] Without successful interventions, a continued rise in obesity, with for example 65 million more obese adults in the U.S. by 2030, can be expected in the next 2 decades, with accompanying health and economic consequences.[2] Most likely, they will come disproportionally more often from lower-SES groups.

Socioeconomic inequalities in obesity as well as underlying behaviors (e.g., physical inactivity, sedentary behavior, and unhealthy dietary intake) are well reported in many Western European countries, including the Netherlands.[3,4] In approaches to reduce inequalities in health, promotion of healthy lifestyles in lower-SES groups is an important entry point.[5] Remarkably little, however, is known about effective strategies to reduce inequalities in obesity and its underlying behaviors.

In line with earlier observations,[6] the large majority of interventions aimed at preventing obesity are developed for general populations. A lack of information on subgroup effects is an important limitation for the implementation of interventions specifically effective for reducing the health gap between lower-SES and higher-SES groups.[7,8] Despite methodologic problems,[9] equity-specific subgroup analyses may offer an important strategy to increase such knowledge.

In the Netherlands, and following the national governmental prevention policy of the Ministry of Health, research funds prioritized the development of effective lifestyle interventions aimed at improving physical activity, healthy diets, and the prevention of obesity in all stages of life. According to an evaluation of the largest Dutch funding organization (The Netherlands Organization for Health Research and Development), almost 30 studies have been conducted since 1990 to develop and evaluate such interventions.[10] Although almost none of them had an explicit emphasis on differential effectiveness across socioeconomic groups, indicators of SES were often measured, predominantly to adjust for its potential confounding effect. Altogether, the studies provide a currently unexploited wealth of information to also test the differences in effect according to SES.

Investigating differential effectiveness is also important because population-wide implementation of effective programs may widen instead of reduce socioeconomic inequalities. According to this "inverse equity hypothesis," for which there is some empirical evidence for smoking,[11–13] more highly educated people may be better equipped to benefit from interventions. There is a lack of such empirical evidence regarding physical activity, diet, and obesity prevention interventions. The aim of this study was to improve knowledge on differential effects through a systematic re-analysis of 26 Dutch intervention studies aimed at the prevention of obesity and the promotion of a healthy diet and physical activity.

Evidence Acquisition

Search Strategy and Selection Criteria

Studies were selected from a systematic inventory (1990–2007) of Dutch intervention studies of programs and projects aimed at contributing to the prevention of obesity, funded by the Netherlands Organization for Health Research and Development.[10] Additional studies were identified through expert contact and a call in a national public health journal.[14] The main inclusion criterion established by the authors of the present study was that the study had to be a Dutch effect evaluation of an intervention aimed at preventing obesity or promoting physical activity or a healthy diet, evaluated after 1990. Studies with a clinical study population were excluded, as were studies with fewer than 100 participants, those in which no indicator of SES was measured, and studies for which the primary researchers could not be reached or were unable to participate.

Quality Assessment

Methodologic quality of the selected studies was assessed by using a scale of suitability of study design and a six-item checklist with methodologic criteria used in a review for tobacco control interventions,[15] adapted from two American public health studies.[16,17] Each study was assigned to one of four categories of suitability of design (Table 1). The most suitable design included at least one before and one after measurement and a control group. Six methodologic criteria were used: representativeness of the study population, adequate randomization, comparability of the experimental and control groups, credibility of data collection, low attrition rate, and attributability of the effects to the intervention[15] (Table 1). Both measures of methodologic quality were assessed through questionnaires developed and interpreted by the authors; they were filled in by a researcher involved in the original effect evaluation, or based on relevant publication(s).

Data Analysis

Analyses were performed in 2010 and 2011. Subgroup analyses were based on the analytic strategy in the original effect evaluation and performed using general guidelines, including the definition of cut-off points for socioeconomic groups. BMI and behavioral outcomes were chosen over determinants of behavior. Analyses were performed by a researcher involved in the original effect evaluation, or by one of the authors of this study. In the latter case, data provided were used to reproduce the original results before performing re-analysis. For one study, analyses were adjusted in consultation with the researchers of the original effect evaluation. For every study, an investigation was made of whether the intervention was more effective in the lower-SES group, the higher-SES group, in both, or in neither (no differential effects).

Given that a lack of statistical power was expected because studies were not designed for these subgroup analyses, and given the fact that the study aimed at identifying patterns of elements

Table 1. Suitability of study design and methodologic quality criteria (Ogilvie et al.[15])

	Description
Suitability of study design	
Category A	The study design includes concurrent comparison groups AND prospective measurement of exposure and outcome.
Category B	The study design includes at least two ''before'' measurements and at least two ''after'' measurements but no concurrent comparison group.
Category C	The study design involves single ''before'' and ''after'' measurements with no concurrent comparison group.
Category D	The study design involves measurements of exposure and outcome made at a single point in time.
Methodologic quality criteria	
Representativeness	Were the study samples randomly recruited from the study population with a response rate of at least 60% OR were they otherwise shown to be representative of the study population?
Randomization	Were participants, groups, or areas randomly allocated to receive the intervention or control condition?
Comparability	Were the baseline characteristics of the comparison groups comparable OR, if there were important differences in potential confounders, were these appropriately adjusted for in the analysis? If there is no comparison group, this criterion cannot be met.
Credibility of data collection instruments	Were data collection tools shown to be credible (e.g., shown to be valid and reliable in published research, OR in a pilot study, OR taken from a published national survey, OR recognized as an acceptable measure (such as biochemical measures of smoking).
Attrition rate	Were outcomes studied in a panel of respondents with an attrition rate of less than 30% OR were results based on a cross-sectional design with at least 200 participants included in analysis in each wave?
Attributability to intervention	Is it reasonably likely that the observed effects were attributable to the intervention under investigation? This criterion cannot be met if there is evidence of contamination of a control group in a controlled study. Equally, in all types of study, if there is evidence of a concurrent intervention that also could have explained the observed effects and was not adjusted for in analysis, this criterion cannot be met.

of interventions particularly effective in lower-SES groups, a guideline-based approach was used to determine the differential effectiveness of each intervention. Decisions were based on the existence of significant interaction effects, point estimates of the effect in one subgroup being outside the 95% CI around the estimated effect in the other subgroup, and on differences in significance ($p<0.05$) of separate subgroup effects. When no effect estimates were available because of the statistical methods used, patterns in subgroup means were used to complement the calculated interaction and separate subgroup effects.

For each study, the decision on differential effectiveness was made by the authors, and decisions were subsequently checked and approved by at least one researcher involved in the original effect evaluation. For some studies, multiple intervention groups (e.g., one basic and one intensified version of the intervention) were part of the experimental design and method for analysis. In these cases, both were included in the decision on differential effectiveness. The results are based on the latest follow-up measurement available, and on anthropometric and behavioral outcomes, except for one study where only determinants of behavior were measured.[18]

Data Synthesis: Harvest Plots

Results were synthesized using harvest plots,[19] in which differential effects were combined with methodologic quality outcomes. In the harvest plot, each study is represented by a bar. Studies on the left side of the plot are more effective in lower-SES groups, whereas studies on the right side are more effective in higher-SES groups. Studies in the middle were not found to be more effective in one of the groups.

Each bar includes (1) the number of methodologic criteria met (maximum of six), annotated on the top of the bar, and (2) studies with relatively large subgroups ($n\geq500$) or significant interaction effects are blue and those without significant interaction effect or with small subgroups ($n<500$) are green. Yellow bars represent studies with missing evidence, where subgroup analyses could not be performed because of a very small subgroup with low SES. Striped bars represent studies with conflicting effects in subgroups, not especially in favor of one of them. There appeared to be no studies with neutral effects, which had comparable effects in both subgroups.

Evidence Synthesis

Selection of Studies

The search yielded 76 studies, of which 33 were eligible for inclusion (Figure 1). Most studies excluded did not evaluate an intervention (n=24), or used a clinical sample (n=10). For five other studies, there was no effect evaluation performed, or the sample was too small. One of the 33 eligible studies had to be excluded because of a missing indicator of SES for the control group, and for

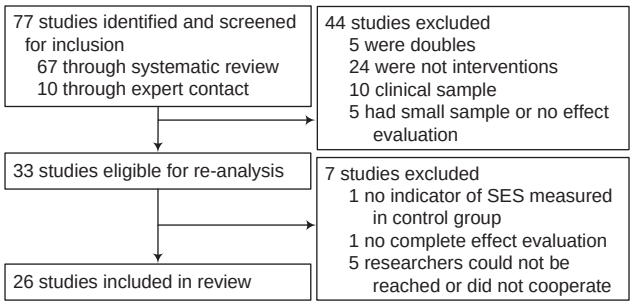

Figure 1. Flowchart of study selection

one other study the effect evaluation was not performed according to plan.

For five studies, a researcher involved in the original effect evaluation could not be contacted or was not able to participate. For two studies, stratified analyses with SES were already part of the original effect evaluation, and the 24 remaining studies were re-analyzed. Thus, a total of 26 studies were included in the study.[20–53]

Study Characteristics

Twelve studies focused on dietary behavior, seven on physical activity, and seven on both. All studies but one[18] had the highest suitability of design, including a pre and post measurement and a control group. Most studies were (cluster) RCTs. The number of methodologic criteria met ranged between two and five, with a mode of five (criteria met are shown in Appendix A, available online at www.ajpmonline.org). Sample sizes ranged from 179 to 5343 participants. Follow-up periods varied between 3 weeks after the intervention to 5 years from the beginning until the end of the study.

Educational level was used as indicator of SES in 25 studies. For two studies,[29,30] average neighborhood income was used. Low SES was defined as primary or lower secondary school (n=22); primary or lower secondary school or senior secondary vocational education (n=2); ≤9 years of education (n=1); or a gross monthly income of <1400 euros (n=1). The percentage of participants with low SES varied greatly between studies (5%–75%), with a mean of 36%. Intervention effects were most often assessed by questionnaire, investigating anthropometry, behavioral outcomes, or determinants of behavior. Studies were conducted in various settings: national, healthcare, community, work, school, and individual.

General Effects of Obesity Interventions

The results of the original effect evaluations of all studies are summarized in Appendix B (available online at www.ajpmonline.org). Overall, interventions had small or modest effects on anthropometrics and obesity-related behavioral outcomes, such as diet and physical activity. In ten studies, a direct measure of obesity and change in BMI or proportion of subjects with (over)weight was evaluated. Four interventions were effective in changing BMI or (over)weight. Eighteen of 26 studies were found to be effective in changing anthropometry or behavioral outcomes.

Differential Effects in Socioeconomic Groups

The results of the equity-specific subgroup analyses of 24 studies can be found in Appendix C (available online at www.ajpmonline.org), as well as the reasoning for the decision on differential effectiveness. Results of the two studies that were already stratified by SES can be found in their original publications.[36,39,53] Seven interventions were more effective in higher-SES than lower-SES groups (Figure 2). Four interventions were found to be more effective in lower-SES than in higher-SES groups. Differential effectiveness could not be demonstrated for 15 intervention studies (i.e., differences emerged in only less than half of the studies). The distribution of studies over the plots remained similar to the overall pattern when studies were distinguished by primary goal of the study (changing diet, increasing physical activity, or both). This was also the case when only lifestyle interventions that were significantly effective in changing behavioral and/or anthropometric outcomes (n=19) were shown.

Setting

Divided by setting in which the study was conducted, most evidence for higher effectiveness among those with low SES was found among studies in the community setting (Figure 3). The only study conducted in a national setting, a mass media campaign to prevent obesity, provided evidence for higher effectiveness among groups with high SES. The single study conducted in a primary care setting, consisting of physical activity advice and counseling sessions offered through general practitioners, was equally effective for groups with higher compared to lower levels of education. Programs in a workplace setting, mainly implemented in companies with high proportions of white-collar workers such as governmental institutes or companies with mainly sedentary work, showed either neutral effects (n=4) or higher effectiveness in groups with high SES (n=2).

The contents of these interventions ranged from adaptations or labeling in workplace cafeterias to counseling programs to encourage employees to be more physically active. School-based interventions mainly consisted of health education and fruit and vegetable distribution programs at primary schools, sometimes including parental involvement. Although two school-based studies seemed more effective among individuals with low SES, others resulted in no differential effects or in higher effectiveness among those with high SES.

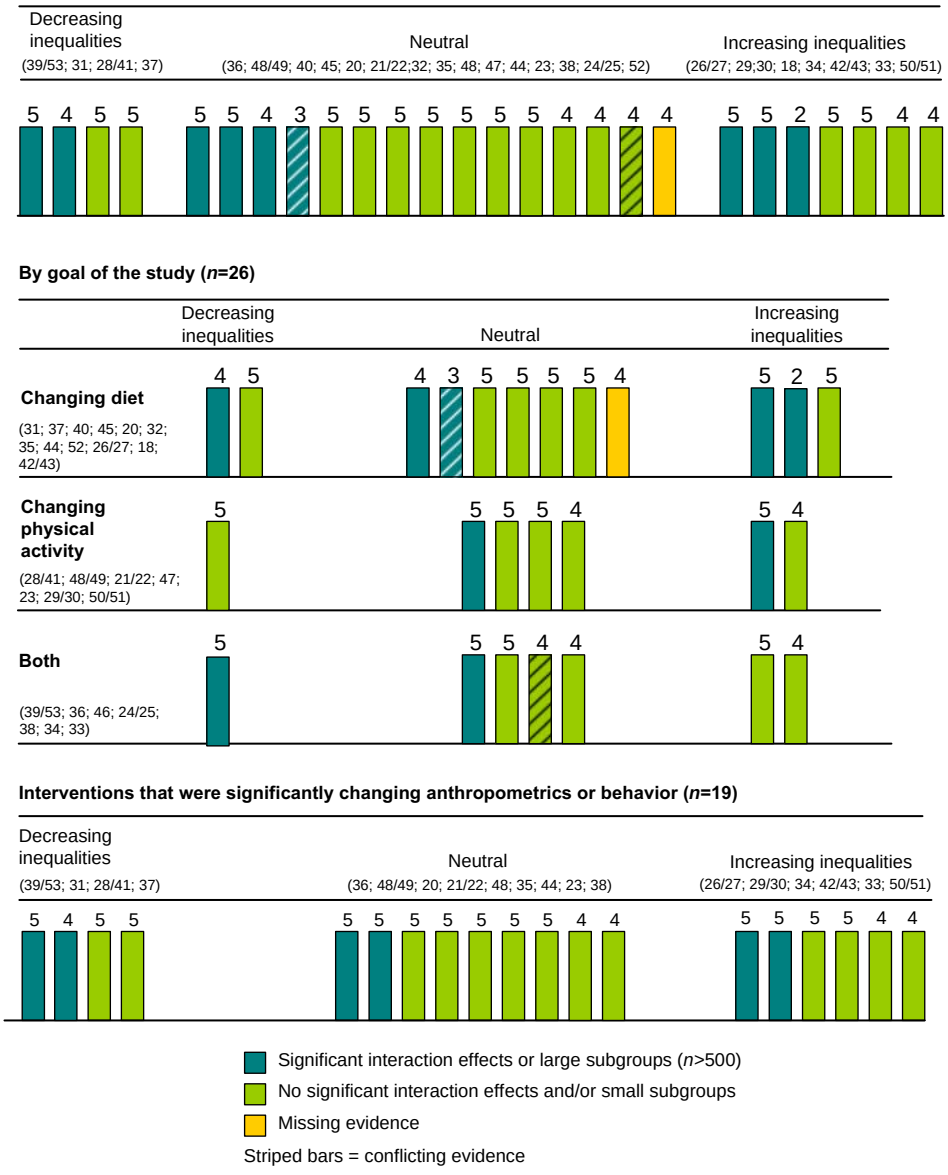

Figure 2. Evidence for socioeconomic inequalities in the effects of obesity, diet, and physical activity interventions
Note: Only one study had a less suitable study design[18]; numbers above the bar refer to the number of methodologic criteria met; numbers in brackets are study reference numbers and correspond to the bars from left to right.

Studies conducted in the individual setting mainly consisted of providing (computer-) tailored feedback programs. They either had no differential effects (n=5) or were more effective among the group with high SES (n=2). Interventions could not be evaluated by type of intervention (e.g., health education or environmental interventions), as nearly all interventions consisted of a combination of various activities.

Age, Intensity, and Follow-Up

Most studied targeted adults (Figure 3). Of the 15 studies conducted among adults, four appeared to be more effective among the high-SES group, whereas one study showed the opposite (greater effectiveness in the low-SES group). For most studies, differential effectiveness could not be demonstrated.

Evidence for studies especially effective in youth with low SES was scarce. No such studies were found for children with low SES. Two studies were conducted among adolescents, consisting of tailored feedback or adaptations in vending machines. The first was more effective and the second less effective in the group with low SES. The small number of three interventions for the elderly showed some evidence for higher effectiveness among those with low SES.

Harvest plots were divided also according to intensity of the intervention program, ranging from very

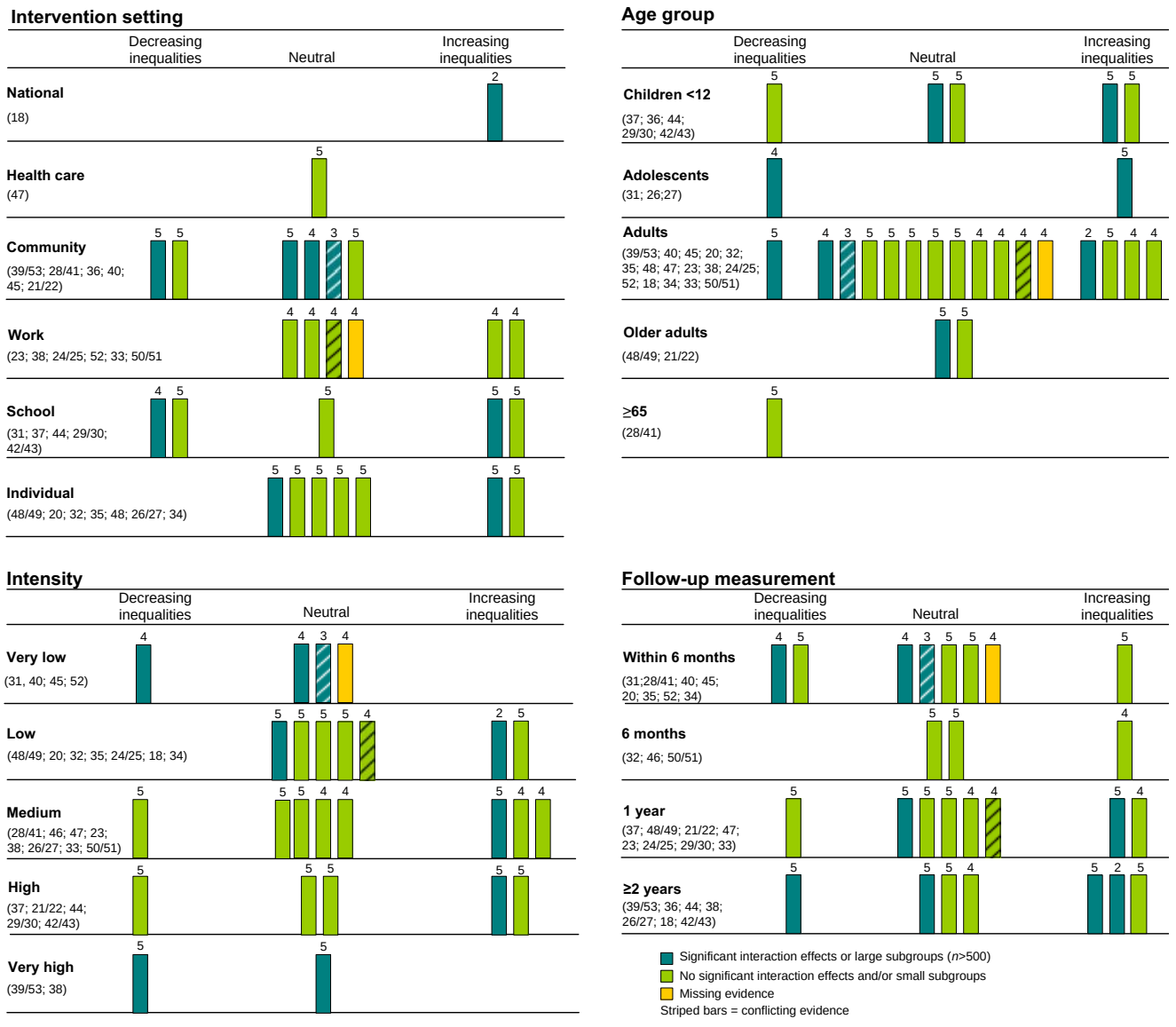

Figure 3. Evidence for socioeconomic inequalities in the effects of obesity, diet, and physical activity interventions by setting, age group, intensity, and time to follow-up

Note: Only one study had a less suitable study design[18]; numbers above the bar refer to the number of methodologic criteria met; numbers in brackets are study reference numbers and correspond to the bars from left to right.

low (no personal contact, subtle environmental changes) to very high intensity (multiple-year programs with a broad range of lifestyle activities). Most interventions were categorized as low or medium intense. The overall pattern showed that (very) low-intensity interventions resulted in no differential effects whereas interventions that were more effective in groups with low SES had at least medium intensity (even though some medium- or high-intensity interventions were more effective in the high-SES group). Finally, short-term as well as long-term results showed scattered patterns of interventions with differential or no differential effects, with a high number of studies more effective among those with high SES among the long-term results.

Discussion

Summary

Equity-specific subgroup analyses for 26 intervention studies showed that for the majority of interventions tested, no evidence for differential effectiveness could be demonstrated. For some studies, better effectiveness in higher-SES groups was found, whereas other studies showed better effectiveness in lower-SES groups. The re-analyses indicate that "high-intensity" community

interventions may be most likely to contribute to reducing SES inequalities in physical activity, diet, or prevention of obesity.

Are Lifestyle Interventions Increasing Inequalities?

As the inverse equity hypothesis stated, interventions might be more effective among higher-SES groups and may further increase socioeconomic inequalities. Based on the current results, there is some reason for concern. First, more interventions were more effective in the higher- than in the lower-SES groups. Second, for children, we found only one study showing a decrease in inequalities. This is alarming, as unhealthy lifestyle behaviors as well as socioeconomic inequalities often develop in one's youth with long-lasting consequences in adulthood.[54–56]

An argument often made for a widening of inequalities is that higher-SES groups may be better equipped, cognitively as well as materially, to benefit from the interventions. The cognitive capacity hypothesis would imply that pure health education interventions may particularly contribute to a widening of inequalities in health behaviors. The present study suggests that such interventions are no longer predominant. Further, the evidence regarding interventions that are mainly health educational (i.e., mass media campaigns and tailored health education interventions) is mixed.

Lifestyle interventions also may generate more effects in higher-SES groups, as a result of differences in participation levels between low-SES and high-SES groups. The current study also found that lower-SES groups often participate less frequently in behavioral intervention programs. The percentage of low-SES participants was 36% on average, and below 30% when community-based interventions (often reaching more individuals with low SES) were left out.

This relatively low participation may be explained by the lack of possibilities among researchers to apply complex and intensive recruitment strategies to involve participants from lower-SES groups. In only a few studies, special measures were taken to involve these hard-to-reach groups, for example, by conducting the study in a community setting. The low participation level perhaps also may be explained by a lack of motivation or interest to participate in interventions among those in lower-SES groups. If health problems are accompanied by other material and psychosocial problems,[57,58] health-related topics may perhaps not receive the main priority.

Are Lifestyle Interventions Decreasing Inequalities?

Although subgroup analyses indicate that interventions developed for the general population will on average not contribute to reducing inequalities in physical activity, diet, or obesity prevention, evidence was found that intensive community-based interventions may contribute to reducing such inequalities. However, the variation in community-based interventions and their effects do not allow more definite conclusions.

Several arguments are made in the literature for interventions in certain settings to have more reach among lower-SES groups, such as school-based interventions. Yet, the current findings suggest that this does not mean that school-based interventions are also likely to be more effective among pupils from lower-SES groups. Few of the studies included were designed with the goal to decrease (socioeconomic) inequalities. To make sure that future interventions are contributing to a decrease in inequalities, it is important to put more emphasis on lower-SES groups by suiting interventions better to their demands.

Strengths and Limitations

Strengths of this study are the systematic approach applied and the inclusion of a large number of intervention studies. To our knowledge, this is the first study to systematically re-analyze and synthesize the effects of interventions aimed at contributing to obesity prevention in low-SES and high-SES groups. The study selection was not based on publication but on funded studies. Therefore, the results were not influenced by publication bias. The approach used—re-analyzing existing information by indicators of SES and summarizing results in harvest plots—can be employed in other countries. Consistent reporting of interventions effects for higher-SES and lower-SES groups will further strengthen the evidence.

Despite the strengths, some limitations must be taken into account. First of all, the re-analyses only concerned intervention studies conducted in the Netherlands. Cross-national differences in economic development, welfare regimes, and healthcare systems may differ, and to the extent that they drive socioeconomic inequalities in health behaviors, generalization of the study findings is complicated.

Yet, there are also reasons to believe that the current findings are important for other countries as well. First, as in the Netherlands, many other Western countries face socioeconomic inequalities in overweight and obesity and therefore may be in need to develop interventions specifically effective in lower-SES groups. Second, the different types of lifestyle interventions included in this study are not specific for the Netherlands. Comparable Internet-, school-, and community-based interventions are conducted in many other (Western) countries including the U.S.[59]

Another limitation is that only few studies were designed with the explicit goal of investigating

socioeconomic differences in intervention effects, and as a consequence most studies may not have been adequately powered. Post hoc (subgroup) analyses are less reliable than overall effect analyses and could even be misleading,[9] and they are often not presented in papers for this reason. However, to not perform them is a lost opportunity, especially when it comes to health equity, as it is very plausible that intervention effects differ between population groups that differ in health outcomes and behavior.

Further, as powering with subgroups in mind is most often not feasible, because it would have major logistic and financial consequences, subgroup analyses are the best evidence available.[9] To enhance the quality of subgroup analyses in future effect evaluations, they should be ideally specified a priori, based on hypotheses, and interpreted using theoretic considerations.[9] Another suggestion is to use a scale to indicate the plausibility of subgroup analyses.[60]

The size of socioeconomic inequality in obesity differs between men and women. It would therefore be relevant to further stratify the findings by gender, but small sample sizes do not allow for a meaningful comparison of this type. Further, the size of socioeconomic inequalities in obesity also may vary across the life course. Smaller or larger inequalities may affect the capacity of interventions to produce a differential effect for higher-SES and lower-SES groups at different stages of the life course. An attempt was made to account for this by presenting harvest plots by age. Also, the relevance of indicators of SES may vary with age. In the current study, mainly education was used, which seems to have the advantage of comparability across studies, but also may have been insufficient to capture the SES of (groups of) study participants.

Another limitation is that studies were very heterogeneous, for example, regarding design and statistical methods. The latest follow-up measurement available for every study was used in order to maximize comparability in the harvest plots. However, for some studies, the effects of the intervention were investigated after a few months, whereas the effects of other studies were based on follow-up measurements after 2 years or even longer. For six (random) studies, short-term data as well as long-term data were re-analyzed.

Over time, the differential effects of three studies changed, in both favorable and unfavorable directions. Thus, the effects of different interventions in low- and high-SES groups may develop differently over time and the results should therefore be interpreted with caution.

Selective participation and attrition of different socioeconomic groups may have influenced the results. Selective participation of individuals with high SES may have resulted in an underestimation of differential effects and thus to an underestimation of the number of studies showing an increase in inequalities in overweight and obesity.

In general, participation rates of people with low SES were low. Although underlying reasons for this low participation level are unclear, it may indicate that they were not always very appealing to lower-SES groups. Selective drop-out of individuals in the lower-SES and higher-SES groups also was not taken into account. When attrition is higher in lower-SES groups this could have resulted in an overestimation of the intervention effects in the group with low SES, especially when no intention-to-treat methods were used, which was the case for the large number of the studies. However, for 14 of the studies, drop-out analyses by SES were available and in most cases, dropout was not higher among groups with low SES, and it was even higher among more highly educated groups in some studies.

Finally, although interventions varied in terms of settings, age of the populations, intensity, and follow-up, they also mainly targeted determinants of health behaviors and obesity in individuals. Whitehead suggested different types of interventions in order to tackle inequalities in health, of which the effect of strengthening individuals for the purpose of reducing inequalities was thought to be limited.[61] Interventions targeting more "upstream" determinants were absent. One study[62] showed that changing prices per unit is effective for the reduction of inequalities in smoking uptake in youth. This may suggest that similar (pricing) strategies need to be applied for the promotion of physical activity, a healthy diet, and the prevention of obesity. Along the same line of reasoning, the present study would have been enriched if large-scale environmental interventions had been present.

Conclusion

This equity-specific re-analysis of evaluations of interventions aimed at contributing to obesity prevention indicates that such interventions may widen as well as reduce socioeconomic inequalities in health behavior and obesity. Equity-specific subgroup analyses contribute to urgently needed knowledge of what may work to reduce socioeconomic inequalities in obesity and underlying health behaviors.

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Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/doi.org/10.1016/j.amepre.2012.11.041.