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Community-based interventions to reduce overweight and obesity in China: a systematic review of the Chinese and English literature

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ABSTRACT

Background Overweight and obesity pose a challenge to public health in China. According to Chinese definition, 303 million Chinese are overweight (body mass index, BMI $\geq$ 24 kg m^{-2}). Among them, 73 million are clinically obese (BMI $\geq$ 28 kg m^{-2}). In line with the global trend, the rate of obesity in China continues to increase, with associated morbidity and mortality. This study was to identify interventions, which are effective in Mainland Chinese society.

Methods All non-drug-controlled interventions ($\geq$3 months) in Mainland China, which used anthropometric outcome measures, were selected from three Chinese and nine international electronic databases (before May 2006) and included in this systematic review.

Results A total of 20 studies met the selection criteria and were included in the review. Among them only one was published in an international journal. Most studies combined at least physical activity, dietary intervention and health education. Seventeen studies (85%) reported significant effects in anthropometric measurement outcomes.

Conclusions Comprehensive interventions with at least physical activity, dietary intervention and health education may be effective in reducing obesity in Chinese children. The role of grandparents as carers in the one-child society is worth considering further. Current evidence of effective interventions for adults is limited. Publication bias in Chinese databases should be taken into account.

Keywords obesity, overweight, prevention, systematic review

Introduction

The rapid increase in overweight/obesity has become a global problem for public health, not only in developed countries but also in developing ones.[1] According to the World Health Organization (WHO) classifications, defining overweight and obesity as a body mass index (BMI, kg m^{-2}) $\geq$25 and 30, respectively, 1.6 billion adults (aged $\geq$15 years) worldwide are currently overweight and more than 400 million are obese.[2] In China, the overweight and obese adults (aged $\geq$18 years) are 195 and 25 million, respectively.[3] This identifies one out of eight overweight people and one out of 16 obese people in the world are Chinese. However, increasing evidence has shown that obesity in China might be underestimated by the WHO's classifications. The Asia-Pacific recommendations (BMIs of 23 and 25) are provisionally built on limited evidence from studies outside Mainland China.[4] New Chinese classifications, with a BMI $\geq$ 24 for overweight and a BMI $\geq$ 28 for obesity, have been recommended based on the data of the Chinese national surveys.[5] Using the Chinese definitions, the estimated number of overweight and obese Chinese in 2005 would reach 303 and 73 million, respectively (Table 1). The rise of overweight/obesity in China started in the late 1980s, mainly caused by increased energy intake and decreased physical activity.[8,9] As elsewhere, it is widely believed that the rising trend will continue if effective intervention strategies are not undertaken to reduce it.

Since the 1990s, a large number of intervention programmes in China, either focusing on reducing obesity as an aim, have been initiated or are ongoing. However, there has been no systematic review of the existing interventions

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Table 1 Prevalence and estimated population of overweight/obesity in China (2005)

Classification	*Overweight*			*Obesity*		
	Definition (BMI, kg m^{-2})	*Prevalence (%)*	*Estimated population (million)*	*Definition (BMI, kg m^{-2})*	*Prevalence (%)*	*Estimated population (million)*
WHO	≥25	17.6	226	≥30	2.6	34
Chinese	≥24	23.2	303	≥28	5.6	73

Sources: Chinese population data in 2005 from the China Statistical Abstract: 2006;[6] prevalence data from the National Nutrition and Health Survey in 2002.[7]

published. Internationally, several systematic reviews have been undertaken to address this issue, but none of these included interventions in China due to challenges associated with the access and translation of Chinese written and published research. Language is also a major barrier to publishing Chinese studies in international English journals. As a result, the Chinese literature has mainly been excluded from international reviews.

Whilst The English-language-published literature highlights the potential for some community-based interventions to be effective in reducing obesity, cost-effective approaches to decrease or even reverse the rising trend of obesity through reducing risk levels are being developed.[1,10] Commonly adopted interventions included healthier diets, promoting physical activity and reducing sedentary time (usually reducing TV viewing), health education, counselling, as well as changes in familial, social and cultural environments, which address the wider determinants of obesity.[11]

This review describes the existing literature in Chinese journals and identifies effective components from interventions with anthropometric measures as outcomes.

Methods

The search strategy was developed according to recommendations by the Cochrane Health Promotion and Public Health Field.[12] The relevant studies published before June 2006 were searched in three Chinese and nine international electronic databases with a combination of subject headings and textwords. Search words (also their counterparts in Chinese) consisted of three main categories: weight-related (including obese, obesity, overweight, weight change, weight gain, weight loss, etc.), intervention-related (including diet, exercise, behaviour therapy, prevention, etc.) and subject-related (including adults, youth, children, etc.). The appendix showed the search strategy in details. The Chinese databases available since 1994 included: Chinese Medical Current Contents, Chinese Biomedical Literature Database and Chinese Journal Full-text Database. The international databases included: MEDLINE, EMBASE, AMED, CINAHL, PsycINFO, as well as four EBM reviews (ACP Journal Club, Cochrane CCTR, Cochrane DSR and DARE).

Studies that evaluated public health programmes aiming to prevent, control or reduce either obesity or obesity-related risk factors (e.g. diet, physical activity, wider environmental factors) implemented in China were included. Community studies in which obesity prevention was not a primary aim but a potential outcome were also included in this review (e.g. interventions to reduce cardio-cerebral vascular diseases in the community in China). The further inclusion criteria were: (i) the intervention duration was not <3 months; (ii) a control group; (iii) anthropometric measures were used as outcomes (e.g. weight, BMI) and (iv) the full text was available. There were no further limits on study design. However, studies assessing clinic-based programmes focusing on the treatment of obesity were excluded from the review. References listed in the articles were also selected following the inclusion and exclusion criteria. 'Effective' interventions were defined as those with statistically significant benefits in outcomes in the intervention group compared to the control one ($P < 0.05$). The quality of studies was assessed from eight aspects based on the Quality Assessment Tool for Quantitative Studies and the appraisal criteria recommended by the Cochrane Effective Practice and Organization of Care Review Group.[12–14]

Results

Search results

In total, 20 studies met the selection criteria and were included in this review, among which, only one was published in an international journal (Fig. 1).[15–34] Figure 2 shows the location of the 20 studies and overweight (BMI ≥ 24) prevalence distribution in China in 2002.[35] There were 14 studies evaluating programmes among children and adolescents in either school or family. The

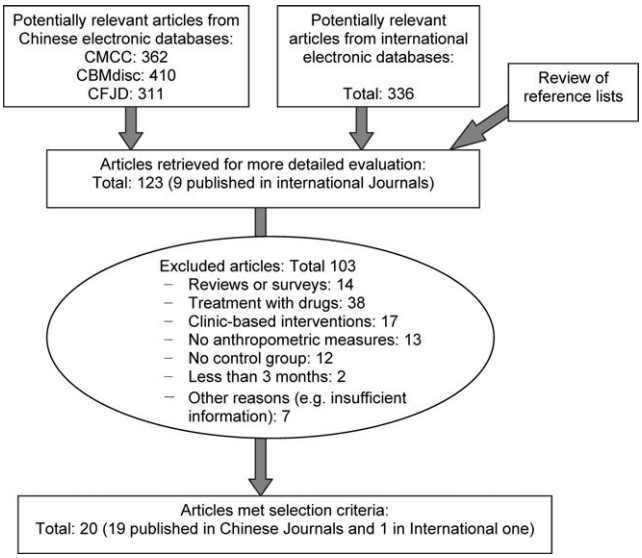
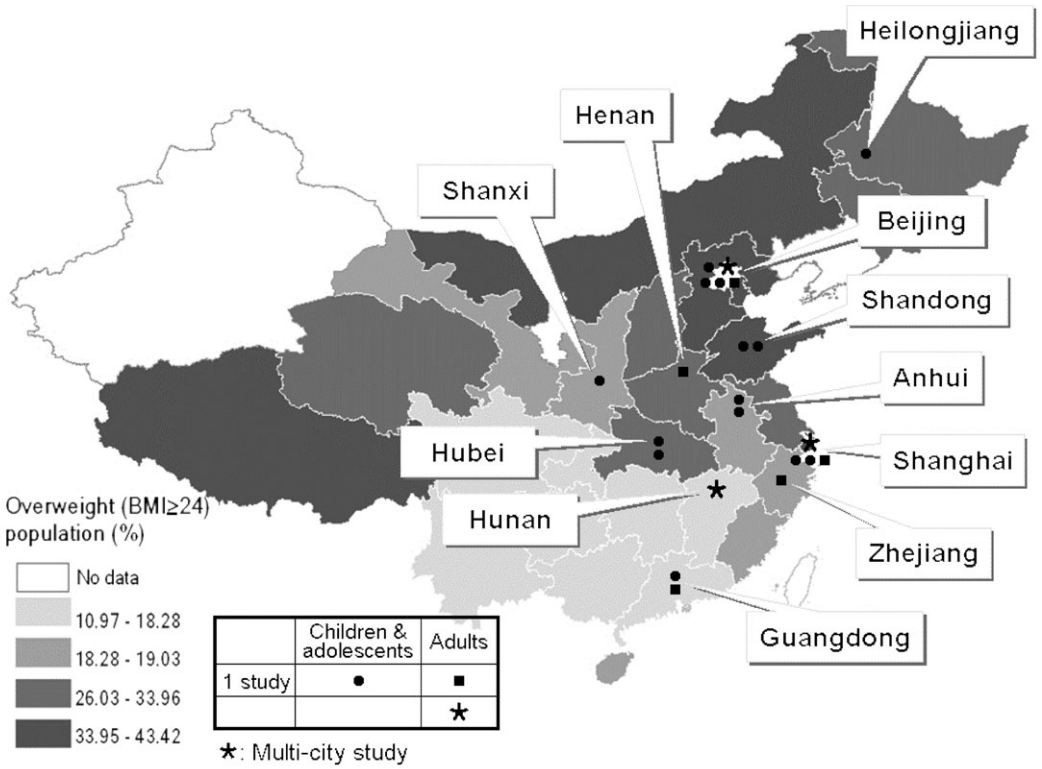


Fig. 1 Diagram of literature search flow.

remaining six assessed interventions among adults and none of them were implemented in the workplace. Except for anthropometric outcomes, most studies also measured changes in knowledge, attitude, behaviour or any combinations of them and showed significant differences between the intervention and control groups.[15–21,24–27,29–34] Table 2 summarizes the assessment of the studies. Tables 3 and 4 separately show the summaries of the included studies undertaken in children and adults. Meta-analysis was not performed because of heterogeneity in the age group of subjects, interventions, duration as well as outcome measurements among studies.

Interventions for overweight/obesity among children and adolescents

Six studies evaluated the integrated population-wide interventions, i.e. interventions that involved both the healthy weight and overweight/obese population groups.[15–20] Except for one study undertaking only health education (among pre-school students),[16] all others included at least physical activity, dietary intervention and health education. The duration of the interventions varied between 1 and 3 years. All studies reported results by changes in obesity prevalence before and right after interventions. One study observed a slight but insignificant increase in obesity prevalence in the intervention group from that in the control one (1.7 versus 0.7%);[20] one found a significant net effect of 17.3% (changes in obesity prevalence in the intervention group minus that in the control one) for girls only;[18] and



*: China's overweight prevalence map was referred to Yang's study.[35] Data source was from the national surveillance on risk behaviors in 145 disease surveillance points throughout China (2002).

Fig. 2 Overweight (BMI $\geq$ 24 kg m^{-2}) prevalence distribution by province and location of 20 studies in China.

Table 2 Summaries of study assessment

Study design and issues addressed	*Number of study*[a]	*References*
Study design		
Randomized clinical trial (RCT)	2	24, 27
Cluster RCT	6	16, 22, 28–31
Non-randomized clinical trial	10	15, 17–21, 23, 25, 26, 34
Quasi-experimental study	2	32, 33
Addressed issues		
Participation rate	12	15, 16, 19, 21–30
Dropout rate	12	15, 16, 19, 21–30
Sufficient intervention description	16	15, 16, 19, 21–34
Contamination	0	
Feasibility	4	15, 19, 27, 34
Adverse effect (descriptive)	7	15, 19, 21, 24–27
Cost-effective (descriptive)	2	19, 27

[a]Total number of studies was 20.

the other four reported significant benefits for both genders, with overall net effects varied from 4.2 to 12.2%.[15–17,19] There were three studies that evaluated the national Health Promoting Schools (HPS) project aiming to control obesity in the primary schools of three cities, but observed inconsistent outcomes (Table 3).[17,18,20] Li *et al.*[17] showed significant benefits in the intervention group for both genders after a 1-year intervention. Wang *et al.*[18] indicated that the intervention was effective only in girls after a similar duration (10 months). Shi *et al.*[20] indicated that the HPS project could not effectively prevent and treat obesity after a longer-term intervention (2 years). The HPS project was co-launched by both the Chinese government and the WHO, and participant schools are required to implement interventions through setting up leadership groups, establishing health-related school policies, closely working with the local community, establishing an inclusive ethos, training staff, improving school physical environment and promoting a sense of responsibility in individuals for their own actions, health-related behaviours and lifestyles.

The other eight studies focused on the overweight/obese population only.[21–28] Six studies implemented comprehensive interventions adopted from 'the routine for prevention and treatment of childhood simple obesity',[36] consisting of promoting physical activity, encouraging a healthy diet, education and behaviour modification at least for 1 or 2 years. Outcomes were measured by different indicators, including change in body weight, BMI and percentage of body weight over the Standard Weight-for-Height recommended by the WHO. All studies reported significant benefits: Yang[22] observed a less weight gain of 2.34 kg; He *et al.*[21] and Jiang *et al.*[27] found a reduced BMI by 2.9 and 2.5 $kg\,m^{-2}$, respectively; and the other three studies showed percentage of over the WHO Standard Weight-for-Height decreased by 7.7–10.6%.[24–26] The remaining two undertook physical activity only for a relatively short duration: one conducted in a university setting, which observed 11.1% obese youth whose weight became normal after 3-month interventions,[23] whereas the one in kindergarten failed to control weight gain through 4-month interventions.[28]

Interventions for adulthood overweight/obesity

All of the six studies in adults were implemented in the community.[29–34] Two interventions focused on reducing obesity, and both of them undertook comprehensive approaches (physical activity, diet and education): one undertook interventions among the general population for 1 year and reported no significant difference in the means for body weight change between the intervention and control groups (−0.16 kg);[34] the other one focused on overweight adults (BMI ≥24) only and found significant effect on decreasing BMI (−1.16 $kg\,m^{-2}$) after 10-month interventions.[29]

The other four studies assessed programmes of prevention and control of cardio-cerebral-vascular diseases in the community, with an aim of reducing obesity. Two studies measured the effectiveness of 2-year individualized interventions in hypertensive subjects (urban residents) and those at risk of hypertension (rural residents), and both of them showed significant effects.[30,31] In the study among urban hypertensives, 6.8% overweight/obese subjects in the intervention group lost their weight to be normal, whereas 5.1% more subjects in the control group became overweight;[30] in the one among rural residents, the overweight rate decreased by 3.5% in the intervention group whereas that increased by 18% in the control one.[31] The remaining two adopted quasi-experimental study design to evaluate long-term effectiveness of interventions. Different samples for each measurement were separately and randomly drawn from the whole community. One study assessed a series of health education and health promotion programmes in the three cities for three times (after 3, 5 and 8 years, respectively) and showed gradually and significantly preventive effects, with a net effect on decreased obesity prevalence of 4.8% after 8-year interventions.[32] The other study measured the effectiveness of interventions in urban, suburban and rural residents after a duration of 5 years, and significant effect was only found in urban adults (decreased BMI of 1.03 $kg\,m^{-2}$).[33]

Table 3 Summaries of 14 studies in childhood and adolescent overweight/obesity

Reference (location[a])	*Target age group or class*	*Population focus[b]*	*Subjects measured outcomes (I/C)[b]*	*Intervention categories[c]*	*Intervention duration[c] (month)*	*Main outcomes at end of trial[d]*
Effective interventions ($P < 0.05$)						
Jiang *et al.*[15] (Beijing)	Primary school, P1–P3	General	725/1031	PA + D + Ed + F	36	Prevalence of obesity; Δ*I*, −3.5%; Δ*C*, +8.7%; Net effect, −12.2%
Feng[16] (Hubei)	Kindergarten, 2–4 years	General	1120/1118	Ed + F	36	Prevalence of obesity; Δ*I*, −4.3%; Δ*C*, +0.2%; Net effect, −4.5%
Li[17] (Guangdong)	Primary school, P3–P4	General	458/unknown	HPS	12	Prevalence of obesity; Δ*I*, −0.4%; Δ*C*, +3.8%; Net effect, −4.2%
Wang[18,e] (Hubei)	Primary school, 9.7 ± 0.7 years	General	812/467	HPS	10	Prevalence of obesity (for girls only); Δ*I*, −5.4%; Δ*C*, +11.9%; Net effect, −17.3%
Liu[19,f] (Anhui)	Secondary school, F1–F3	General	2346/2834	PA + D + P + Ed + BM + F + En	36	Prevalence of obesity; Δ*I*, −2.8%; Δ*C*, +2.7%; Net effect, −5.5%
He[21] (Shandong)	Kindergarten, 4–6 years	Obese	24/19	PA + D + Ed + BM + F	12	Mean BMI (kg/m^2); Δ*I*, −1.4; Δ*C*, +1.5; Net effect, −2.9
Yang[22] (Shanghai)	Kindergarten, 3–4 years	Obese	Ob: 96/96	PA + D + Ed + BM + F + En	12	Mean weight (kg); Δ*I*, +0.87; Δ*C*, +3.21; Net effect, −2.34
Zang[23] (Shandong)	University, 18–21 years	Obese	81/93	PA	3	Cure rate of obese students (BMI becoming normal); Δ*I*, 11.1%; Δ*C*, 0%; Net effect, 11.1%
Yue[24] (Anhui)	Primary and secondary school, 7–16 years	Obese	47/47	PA + D + P + Ed + F	14	Mean percentage of over standard Weight-for-Height (%)[g]; Δ*I*, −13.2%; Δ*C*, −2.6%; Net effect, −10.6%
Jiang[25] (Shanxi)	Primary school, 7–12 years	Obese	18/18	PA + D + P + Ed + F + IR	24	Mean percentage of over standard Weight-for-Height (%)[g]; Δ*I*, −8.6%; Δ*C*, −0.9%; Net effect, −7.7%
Yin[26] (Heilongjiang)	Primary school, mean age: 9.8 years	Obese	20/20	PA + D + P + Ed + F + IR	12	Mean percentage of over standard Weight-for-Height (%)[g]; Δ*I*, −11.1%; Δ*C*, −0.6%; Net effect, −10.5%
Jiang[27] (Beijing)	Secondary school, mean age of 13.2 years	Obese	33/35	PA + D + P + Ed + F + En + IR	24	Mean BMI (kg/m^2); Δ*I*, −2.6; Δ*C*, −0.1; Net effect, −2.5

Non-effective interventions ($P > 0.05$)							
Shi[20] (Beijing)	Primary school, P3–P4	General	747/755	HPS	24	Prevalence of obesity; ΔI, +1.7%; ΔC, +0.7%; Net effect, +1.0%	
Ma[28] (Shanghai)	Kindergarten	Obese	91/97	PA + En	4	Mean weight (kg); ΔI, 0.84; ΔC, 1.03; Net effect, −0.19	

[a]Province or municipality directly under the central government.[7]

[b]General: subjects were the whole population; Obese: subjects were obese population according to the WHO standard Weight-for-Height Z-scores if they were aged under 7; those aged 7–17 were classified according to the Chinese BMI cut-off points.

[c]PA, physical activity (e.g. actual engagement in physical activities, reducing sedentary behaviours); D, diet (e.g. intervention on energy intake); P, psychosocial (e.g. focus on self-esteem, body image, peer support and stress management); Ed, education (e.g. education on healthy eating, active living); BM, behaviour modification (e.g. motivational reinforcement); F, family (e.g. Involvement of family/parents); En, environment (e.g. environmental modification within community, cafeteria menus, food/meal supply); IR, incentives or rewards (e.g. Stickers, money, sports equipment); HPS, health-promoting schools project, with obesity control as an entry point, jointly held by China and WHO, including interventions of PA, D, Ed, BM, F, En and IR.

[d]ΔI, deference in before-and-after measurements in intervention group; ΔC, deference in before-and-after measurements in control group, Net effect, $\Delta I - \Delta C$.

[e]effective only for girls.

[f]Participants had different intervention durations (1–3 years) because of their graduation.

[g]Percentage of over standard Weight-for-Height (%) = (children's weight − WHO standard Weight for Height)/WHO standard Weight for Height (%).

Discussion

Main finding of this study

Twenty studies in China met our selection criteria and were reviewed in this study: 14 were interventions for childhood and adolescent obesity, and six were in adults. Thirteen studies combined at least physical activity, dietary intervention and health education. Seventeen studies reported significant effects in anthropometric measurement outcomes.

What is already known on this topic

Overweight and obesity rates in Mainland China increased by 46.8 and 80.6%, respectively, in the decade between 1992 and 2002 and pose an increasing challenge to the population's health as the country becomes increasingly affluent.[9] At present, two major features of the overweight/obesity distribution in China are: people living in the north are at higher risk than those in the south; rates among urban populations are higher than in rural ones.[9] Evidence of effective interventions in the community in China was previously unknown. Internationally, there are numerous systematic or literature reviews addressing this public health issue published though none of them included the studies in China.[37–45] Doak *et al.*[37] showed that most prevention measures for overweight and obesity reviewed found significant benefits, with physical education in schools and reducing television viewing being more effective.[37] Sharma[38] reviewed 11 interventions in the UK and the USA and indicated that TV viewing may be the most modifiable, followed by physical activity and eating behaviours. However, Summerbell *et al.*[39] concluded that evidence was not enough to support that the physical activity and/or healthier diet were effective to prevent childhood obesity; although comprehensive strategies combined both, together with psychosocial support and environmental change they might help.[39] Connelly *et al.*[40] indicated that the previous systematic reviews of controlled trials of interventions for childhood obesity had not applied practice-relevant guidance. Their systematic review found that the major factor distinguishing effective from ineffective studies was the provision of aerobic physical activity on a 'compulsory' rather than 'voluntary' basis. Gibson *et al.*[42] concluded that there was little evidence in the effectiveness of dietary interventions (with a low-fat energy-restricted diet as a core component) for interventions of childhood obesity. As for adults, evidence showed that low-fat diets, not low- or very low-calorie diets, were associated with weight loss.[43] Dietary interventions combined with exercise resulted in a greater weight reduction than each of them alone,[43,44] whereas both of

Table 4 Summaries of six studies on adulthood overweight/obesity

Reference (location[a])	*Target age group*	*Population focus[b]*	*Subjects measured outcomes (I/C)[b]*	*Programme focus*	*Obesity-related intervention categories[c]*	*Duration (month)*	*Main outcomes at end of trial[d]*
Effective interventions ($P < 0.05$)							
Tao[29] (Shanghai)	40–60 years	Overweight (BMI $\geq$ 24)	119/96	Obesity prevention and control	PA + D + Ed + BM + IR	10	Mean BMI (kg/m^2); ΔI, −1.09; ΔC, +0.07; Net effect, −1.16
Chen[30] (Guangdong)	>35 years	Hypertensive	1238/599	Hypertension prevention and control	Ed + C + D	24	Proportion (%) of overweight (BMI $\geq$25); ΔI, −6.8%; ΔC, +5.1%; Net effect, −11.9%
Xiao[31] (Beijing[e])	>35 years	At high risk of hypertension	58/39	Hypertension prevention and control	Ed + C	24	Proportion (%) of overweight (BMI $\geq$25); ΔI, −3.5%; ΔC, +18%; Net effect, −21.5%
Jiang[32] (Beijing, Shanghai, Hunan)	Adults (mean age of 52.7–54.6 years)	General	2500–3000/ 2500–3000 for each	Integrative interventions for cardio-cerebral-vascular diseases in community	Ed + C + En	96	Prevalence of obesity (BMI $\geq$ 30); ΔI, −1.2%; ΔC, +3.6%; Net effect, −4.8%
Tang[33] (Zhejiang[f])	Adults	General	1500–2500/ 1500–2500	Integrative interventions for hypertension in community	Ed + C + D	60	Mean BMI (kg/m^2), urban residents only; ΔI, −0.05; ΔC, +0.98; Net effect, −1.03
Non-effective interventions ($P > 0.05$)							
Han[34] (Henan)	15–75 years	General	2400/1200	Integrative interventions for obesity in community	Ed + En + D + PA + C	12	Mean weight (kg); ΔI, −0.04; ΔC, +0.12; Net effect, −0.16

[a]Province or municipality directly under the central government.

[b]General: subjects were the whole population.

[c]PA, physical activity (e.g. actual engagement in physical activities, reducing sedentary behaviours); D, diet (e.g. intervention on energy intake); P, psychosocial (e.g. focus on self-esteem, body image, peer support and stress management); Ed, education (e.g. education on healthy eating, active living); C, counselling (e.g. on diet and physical exercise); BM, behaviour modification (e.g. motivational reinforcement); F, family (e.g. involvement of family/parents); En, environment (e.g. environmental modification within community, cafeteria menus, food/meal supply); IR, incentives or rewards (e.g. stickers, money, sports equipment).

[d]ΔI, deference in before-and-after measurements in intervention group; ΔC, deference in before-and-after measurements in control group; Net effect, $\Delta I - \Delta C$.

[e]rural area of Beijing.

[f]including urban, suburban and rural areas, effectiveness only in urban residences.

them plus psychological interventions (e.g. behavioural and cognitive-behavioural strategies) were most effective.[45]

What this study adds

This is the first systematic review of interventions for obesity in China published in both local Chinese journals and international English ones. All non-drug-controlled interventions in both children and adults were selected according to the systematic search strategy.

Interventions for children and adolescents

Comprehensive interventions in China to reduce childhood obesity may be effective, especially those focusing on obese populations. Physical activity, dietary interventions and health education are the effective components. Engaging children's interest is a key factor for effective physical activity, while involvement of parents is determinative to effective dietary interventions. In addition, effective components of dietary intervention include eating slowly and eating low-caloric foods first (e.g. soup, vegetable) during a meal, avoiding sugary drink, snack and western fast foods as well as no eating after supper. Health education encouraging physical activity, healthier eating and better knowledge of health is likely to be an effective component. The HPS project has strengthened links between schools and local communities. However, that was not shown to make a direct contribution to reduce obesity in children. It was not possible to comment on the sustainability of the impact because all included studies estimated interventions right after their implementation.

Traditional and political differences from other countries may make a difference when implementing interventions for childhood obesity in China. In the Chinese tradition and culture, fat people are thought to be happy, lucky, rich and have a high quality of life.[35] This may lead to children being over-fed. Children are also likely to be over-protected, as the impact of the one-child policy has predominantly led to only one child in most urban families, where most studies took place.[46] Promoting fatness as wellness may well be more likely to occur when grandparents live as part of the family. Within Chinese families, grandparents are very influential, reflecting the Chinese veneration of age and promotion of family values. Many older retired people have time to help with childcare and their thinking and behaviours may be more heavily influenced by Chinese tradition resulting in a preference to over-feed children and be over-protective towards them. As a result, living with grandparents may be a significant barrier to address when implementing interventions.[16–21,24–26]

Interventions for adults

From the literature reviewed, the current evidence is insufficient to draw a conclusion on the effectiveness of community-based interventions for adult obesity. First, the number of interventions focusing on adulthood obesity was limited (two studies). Moreover, community-based interventions for cardio-cerebral-vascular diseases (a target of reducing obesity) were initiated in 31 demonstrations during 1996–2003;[47] among them, only four met our selection and exclusion criteria and were reviewed. As a result, it is not possible to make any conclusion in relation to their effectiveness.

Tang *et al.*[33] implemented a programme in urban, suburban and rural residents, but it was found to be effective in urban residents only. One possibility may be that the development of obesity and its determinants are at different stages in urban and rural areas. The main drivers of obesity in an area are its economic growth and social development, such as the process of urbanization, modernization and globalization. However, there are large disparities between urban and rural areas: urban areas are relatively well developed and overweight/obesity has become a health threat to the public there, whereas rural areas are currently developing, and poverty and underweight are still prevalent. That might result in significant differences in the effectiveness of interventions. Taking the results from the national nutrition and health survey in 2002 as an example, the overall prevalence of obesity (BMI $\geq$28) in large cities (10.6%) was about quadruple of that in Class 4 rural areas (the poorest ones, 2.7%),[48] whereas the prevalence of underweight of children $<$5 years old in urban areas (3.1%) was one-third of that in rural areas (9.3%).[7] Thus, interventions need to be locally tailored.

Limitations of this study

We suspect that there is likely to be a publication bias in favour of the positive results observed. Some interventions were excluded from this review because of suboptimal study quality (e.g. no control group, limited description of interventions or unclear results in anthropometric measurements), whereas others were excluded as they had provided inadequate details about evaluations. We also searched studies on relevant governmental websites (e.g. national and local health sections and the Centre for Disease Control and Prevention, CDC) and published conference reports, but failed to find studies meeting our selection criteria. We further sought advice from experts in the national and several local CDCs. They indicated that assessments of intervention programmes were not paid enough attention in

China until recent years, which resulted in the fact that some measured outcomes were not presented, especially for those without statistical significance or those unsupportive of their hypotheses. As a result, it is likely that the effectiveness of interventions may be over-estimated in our study. In addition, along with the 'Guidelines to prevention and control of overweight/obesity for Chinese adults' issued in 2003, new and well-planned community-based interventions have been launched and are still ongoing, but their evaluations are so far unavailable and therefore not included in this review.

Conclusions

We conclude that comprehensive interventions with physical activity, dietary intervention and education may be effective in reducing childhood and adolescent obesity in China, whereas existing evidence is too limited to draw a conclusion of the effectiveness of community-based interventions in adults. The limitations of the study, e.g. publication bias and suboptimal study quality of primary studies, need to be taken into account. There is an urgent need for more interventions to reduce obesity in China, with high quality in study design, organization, management, implementation and assessment. Engaging the family can ensure the effectiveness of interventions, and since grandparents may be a barrier to the implementation of healthy policies to prevent obesity, future initiatives should include targeting them as well as promoting safe exercise environments,[10] which may be helpful to increase children's physical activity levels. Unlike in developed countries (e.g. the US and the UK), costs of healthy traditional foods (e.g. vegetables) are still relatively lower in contemporary China, compared with those of westernized high-energy foods, and should be promoted. In addition, further community-based interventions need to be localized and tailored to address local circumstances of the huge and diverse Chinese population.

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Appendix: search strategy for English literature in international electronic databases

Searching date: 01 July 2006.

Databases: CDSR, ACP Journal Club, DARE, CCTR, AMED, British Nursing Index, CINAHL, EMBASE, INSPEC BIOMEDICAL, IPAB, Ovid MEDLINE(R) In-Process, Other Non-Indexed Citations, Ovid MEDLINE(R), Ovid MEDLINE(R) Daily Update, PsycINFO.

No.	*Search history*	*Results*
1	Exp OBESITY/	144 874
2	Exp Weight Gain/	40 792
3	Exp Weight Loss/	44 657
4	obes$.af.	210 037
5	(weight gain or weight loss).af.	131 574
6	(overweight or over weight or overeat$ or over eat$).af.	59 418
7	weight change$.af.	11 499
8	((bmi or body mass index) adj2 (gain or loss or change)).af.	2968
9	or/1-8	352 500
10	Exp Behavior Therapy/	65 633
11	Exp Social Support/	72 189
12	Exp Family Therapy/	24 118
13	Exp Psychotherapy, Group/	28 567
14	((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.	186 229
15	(group therapy or family therapy or cognitive therapy).af.	116 183
16	((lifestyle or life style) adj (chang$ or intervention$)).af.	11 535
17	counsel?ing.af.	215 138
18	social support.af.	108 652
19	(peer adj2 support).af.	5636
20	(children adj3 parent$ adj therapy).af.	4875
21	or/10-20	542 449
22	Exp OBESITY/dh [Diet Therapy]	4581
23	exp Diet, Fat-Restricted/	4891
24	Exp Diet, Reducing/	10 021
25	Exp Diet Therapy/	104 094
26	exp FASTING/	46 771
27	(diets or diet or dieting).af.	417 920
28	(diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.	36 092
29	(low calorie or calorie control$ or healthy eating).af.	7078
30	(fasting or modified fast$).af.	94 953
31	Exp Dietary Fats/	71 330
32	(fruit or vegetable$).af.	84 092
33	(high fat$ or low fat$ or fatty food$).af.	29 009
34	formula diet$.af.	1220
35	or/22-34	603 615
36	Exp EXERCISE/	132 494
37	Exp Exercise Therapy/	44 104
38	exercis$.af.	399 463
39	(aerobics or physical therapy or physical activity or physical inactivity).af.	185 065
40	(fitness adj (class$ or regime$ or program$)).af.	2296
41	(aerobics or physical therapy or physical training or physical education).af.	143 107
42	Dance therapy.af.	1165
43	Sedentary behavio?r.af.	924

44	or/36-43	548 802
45	exp Complementary Therapies/	198 750
46	(alternative medicine or complementary therap$ or complementary medicine).af.	47 841
47	(hypnotism or hypnosis or hypnotherapy).af.	27 030
48	(acupuncture or homeopathy or homoeopathy).af.	50 893
49	(chinese medicine or indian medicine or herbal medicine or ayurvedic).af.	39 003
50	or/45-49	270 475
51	((diet or dieting or slim$) adj (club$ or organi?ation)).af.	286
52	(weightwatcher$ or weight watcher$).af.	179
53	(correspondence adj (course$ or program$)).af.	463
54	(fat camp$ or diet$ camp$).af.	149
55	or/51-54	1050
56	Exp Health Promotion/	81 895
57	Exp Health Education/	217 405
58	(health promotion or health education).af.	252 321
59	(media intervention$ or community intervention$).af.	14 533
60	Health promoting school$.af.	1562
61	((school or community) adj2 program$).af.	55 402
62	((school or community) adj2 intervention$).af.	30 676
63	(family intervention$ or parent$ intervention).af.	19 998
64	(parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.	89 245
65	or/56-64	492 522
66	Exp Health Policy/	132 871
67	Exp Nutrition Policy/	46 526
68	(health polic$ or school polic$ or food polic$ or nutrition polic$).af.	116 442
69	or/66-68	197 109
70	Exp OBESITY/pc [Prevention & Control]	7922
71	Exp Primary Prevention/	91 875
72	(primary prevention or secondary prevention).af.	53 282
73	(preventive measure$ or preventative measure$).af.	20 917
74	(preventive care or preventative care).af.	13 442
75	(obesity adj2 (prevent$ or treat$)).af.	20 981
76	or/70-75	184 912
77	Randomized controlled trial.pt.	436 318
78	Controlled clinical trial.pt.	143 017
79	Exp Controlled Clinical Trials/	481 605
80	Exp Random Allocation/	97 360
81	Exp Double-Blind Method/	215 659
82	exp Single-Blind Method/	22 314
83	exp Placebos/	108 325
84	*Research Design/	17 240
85	Exp Intervention studies/	6 781 682
86	Exp Evaluation studies/	685 207
87	exp Comparative Study/	1 618 242
88	Exp Follow-Up Studies/	589 708
89	Exp Prospective Studies/	356 996
90	Exp Cross-over Studies/	49 880
91	Clinical trial.tw.	101 958
92	Clinical trial.pt.	738 245
93	Latin square.tw.	4369
94	(time adj series).tw.	17 627
95	(before adj2 after adj3 (stud$ or trial$ or design$)).tw.	4 199 243

Continued

Continued

No.	*Search history*	*Results*
96	((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.	275 926
97	placebo$.tw.	310 156
98	random$.tw.	987 509
99	(matched communities or matched schools or matched populations).tw.	239
100	control$.tw.	3 104 233
101	(comparison group$ or control group$).tw.	362 634
102	matched pairs.tw.	5141
103	(outcome study or outcome studies).tw.	12 577
104	(quasiexperimental or quasi experimental or pseudo experimental).tw.	7872
105	(nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.	20 872
106	prospectiv$.tw.	509 985
107	volunteer$.tw.	233 606
108	or/77-107	12 432 509
109	21 or 35 or 44 or 50 or 55 or 65 or 69 or 76	2 418 942
110	9 and 109 and 108	94 358
111	Animals/	4 029 322
112	exp CHILD/	1 736 608
113	exp ADOLESCENT/	1 555 980
114	exp CHILD, PRESCHOOL/ or CHILD/	1 574 976
115	exp INFANT/	884 955
116	(child$ or adolescen$ or infant$).af.	4 007 066
117	(teenage$ or young people or young person or young adult$).af.	271 647
118	(schoolchildren or school children).af.	62 329
119	(pediatr$ or paediatr$).af.	1 053 085
120	(boys or girls or youth or youths).af.	231 349
121	or/112-120	4 324 185
122	110 not 111	86 178
123	122 and 121	25 799
124	China.mp. [mp = ti, ab, tx, kw, ct, ot, sh, hw, it, tn, dm, mf, id, rw, nm, tc]	72 846
125	Chinese.mp. [mp = ti, ab, tx, kw, ct, ot, sh, hw, it, tn, dm, mf, id, rw, nm, tc]	137 138
126	124 or 125	186 000
127	126 and 123	390
128	Remove duplicates from 127	336
129	128	336