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IMPROVING WEIGHT STATUS IN CHILDHOOD: RESULTS FROM THE *eat well be active* COMMUNITY PROGRAMS

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INTRODUCTION

There is a clear need for effective prevention and treatment interventions to manage the high prevalence of childhood overweight globally (Swinburn et al. 2011). It is well recognised that changes in the social and economic environment in the last three decades have been a major contributor to altered eating and activity patterns resulting in positive energy balance. The most recent update to the Cochrane review of interventions for preventing obesity in children (Waters et al. 2011) identified that the majority of childhood obesity prevention intervention evaluations were short-term (12 months or less) and largely focussed on individual behaviour change. Also from this review there is now some early evidence that settings-based obesity prevention interventions are effective at reducing body mass index in the short term. However, given the short-term nature of these interventions, sustainability of this change is unclear, and stronger evidence from larger-scale evaluations is needed about what intervention components are feasible to be embedded into children's settings and systems (e.g. the school environment) to be able to translate and scale up research findings into effective public health approaches. Until recently, effective obesity prevention interventions have largely drawn upon behaviour change theories, which appear to be unlikely to produce sustainable change in outcomes if they do not consider the broader social and environmental context (de Silva-Sanigorski and Economos 2010; Swinburn et al. 2011). Models based on ecological theory (McLeroy et al. 1988; Swinburn et al. 1999) show the complex interaction between individuals' behaviour and their broader environments, that influence eating and activity. A community-based, capacity-building approach aims to promote sustainable skill development and increase the ability of individuals to improve environments that promote health outcomes (de Silva-Sanigorski et al. 2010a).This presents a promising approach to obesity prevention, and evidence is needed on processes and outcomes of interventions guided by such theories.

One type of intervention is 'whole of community' where a wide range of actions are implemented across multiple settings. . The *eat well be active* Community Programs (*ewba*), funded by the Health Promotion Branch of SA Health (Government of South Australia) for five years is one such project. Two communities were selected: one metropolitan and one regional. The aim of *ewba* was to contribute to the healthy weight of children and young people (0-18 years) and their families in these communities, through increasing their healthy eating and physical activity, by working in partnership with a variety of settings to address both individual behaviour and environmental barriers.

This project is one of a number of similar demonstration projects that have been implemented in Australia and New Zealand in the last decade e.g. Be Active Eat Well (Sanigorski et al. 2008a), Romp & Chomp (de Silva-Sanigorski et al. 2010b), *Fun n Healthy in Moreland!* (Moore and Gibbs 2010), and Project APPLE (Taylor et al. 2007). Similar to existing interventions, *ewba* used a social-ecological theoretical framework to guide the intervention approach rather than individualised, behavioural approaches. In contrast however, *ewba* targeted a wider age range through a range of settings involving children 0- 18 years and was implemented in both regional and metropolitan community settings. A comprehensive evaluation framework was developed in line with recommendations for such complex public health interventions (Swinburn et al. 2007). The primary evaluation objectives were to assess the effectiveness of the *ewba* intervention with respect to increasing the prevalence of healthy weight among children, and improving behaviours, attitudes and environments linked to healthy eating and physical activity, in both metropolitan and regional socio-economically disadvantaged communities. The purpose of this paper is to report the weight-related outcomes.

METHODS

ewba Community Programs (ewba) – intervention development, implementation & evaluation design

ewba was a multi-setting, multi-strategy healthy eating and physical activity project that targeted children aged 0–18 years and their families. It was conducted in Morphett Vale, an outer-metropolitan suburb (population approx. 23,000), and the rural city of Murray Bridge (population approx. 18,000) in South Australia. The two communities were selected based on total population size, indicators of higher relative socio-economic disadvantage (Australian Bureau of Statistics 2006), higher than state-average prevalence of overweight, high proportions of Aboriginal and Torres Strait Islander (Indigenous) people relative to the state average, existing infrastructure and networks relevant to the project, , suggesting the communities could support the proposed project.

Theoretical frameworks

Intervention approach and development was based on primary health care principles and informed by multiple health promotion theories including an environmental change model (social ecological model (McLeroy et al. 1988; Swinburn et al. 1999)), with a community development and capacity building approach. This theoretical basis was used to develop a set of guiding principles for *ewba* which included foci on equity, sustainability, inclusiveness, intersectoral action, community development and positive approaches. These guiding principles informed all stages of the project including intervention planning, development, implementation and evaluation.

Intervention implementation

An action plan was developed for each *ewba* community through comprehensive community consultation, informed by the best available evidence and expert knowledge and prioritised according to the program's guiding principles. . The intervention utilised a strong community development approach, including ongoing stakeholder engagement through local action groups, and is described in detail elsewhere (Pettman et al. 2010). The nature of the intervention was multi-strategy in multiple settings, comprising numerous actions under six strategy types: workforce development and peer education; policy; infrastructure improvements; programs and resources; promotion/local marketing; and community development. Settings in which the intervention was implemented included child care, education, youth, homes, health, welfare and indigenous agencies, recreation spaces and community settings. Examples of specific strategies included peer leadership programs for school students, healthy policies and workforce development for stakeholder agencies such as schools and child care, and physical environment improvements to outdoor play spaces and water fountains in schools and public areas. Details of the intervention strategies are available elsewhere (Pettman et al. 2010; Magarey et al. 2011) and a range of intervention summaries that provide detail on how implementation was developed and operationalised are available online (www.sahealth.gov.au).

Study design

A comprehensive mixed-methods evaluation framework was designed and this has been described elsewhere (Pettman et al. 2010; Jones et al. 2008).The purpose of this paper is to describe changes in the primary quantitative outcome.

The quantitative evaluation was a quasi-experimental design (Campbell and Stanley 1966) involving repeat cross-sectional surveys pre and post intervention, with intervention communities (INT) and non-randomised comparison communities (COMP). The COMP sites were selected to match INT sites as closely as possible based on population size, level of socio-economic disadvantage (SEIFA IRSD(Australian Bureau of Statistics 2006)) and proportion of the Aboriginal and Torres Strait Islander population. The metropolitan comparison site was referred to as Sea and Vines, which aligned with the relevant State Government Education and Children's Services District, within the same Local Government area as the intervention community Morphett Vale. The regional comparison site was Port Pirie Regional Council, including the city of Port Pirie and its surrounding rural towns.

Two age ranges were selected as 'litmus groups' for evaluation purposes: primary school children aged 10-12 years; and pre-school children aged 4-5 years. Repeat-cross sectional surveys were conducted with INT and COMP communities at baseline (2006) and follow-up (2009) (pre- and post-intervention) providing independent samples and no within–individual changes.

Height and weight data for pre-school children (4 to 5-yearolds) were sourced from state-wide population monitoring data collected by child health nurses of the Children, Youth and Women's Health Service (CYWHS). Measures of children resident in the postcodes in intervention and comparison sites, and taken between January – December 2006 and 2009, were used. Measures for children aged 10-12 years were conducted in the schools in the defined communities. Details of this process have been reported (Wilson et al. 2010)but briefly height, weight and waist circumference (WC) of primary school children (10 – 12 years old, year levels 5 – 7) were measured by trained study staff attending the schools. All public and private primary schools in INT and COMP communities were invited to participate in the baseline evaluation (September – November 2006) and again at follow-up (September – November 2009).

Detailed demographic information was not available for pre-school children and primary school children completed self-reported surveys so such questions were not appropriate. Ethics approval for data collection was granted by the Human Research Ethics committees of SA Health (Government of South Australia), and the Department of Education and Children's Services. The evaluation study is registered with the Australian Clinical Trials Registry (ACTRN12607000414415).

Analysis of anthropometric data

BMI was calculated as weight (kg)/height (m^2). BMI and WC data were standardised as BMI and WC z-scores using LMS Growth Microsoft Excel module, which uses reference data published by Cole et al 1995 (Cole et al. 1995) and McCarthy et al 2001 (McCarthy et al. 2001). Weight status was determined from BMI by applying International Obesity Task Force (IOTF) cut-points to identify overweight or obesity (Cole et al. 2000), and internationally derived cut-points to identify thinness (Cole et al. 2007). The grade 2 thinness cut point was applied. Weight status was also determined using WC z-scores and applying cut-points of the 91 and 98 centiles to define overweight and obesity respectively (McCarthy et al. 2003).

Data were tabulated and split by INT and COMP. Data were further split by boys/girls and by metropolitan/country sites to determine whether significant differences existed by gender and place of residence. To determine intervention effect, a basic change score analysis was used, in accordance with the repeat cross-sectional design. For continuous data, fixed-effects modelling was used with school number included as a random factor in the school data, to account for clustering in schools. For categorical data (weight status categories) χ^2 test was used (2X2 factorial cross-tabulation with chi-square) using exact or monte carlo significance, which ever of the two was possible. Data analysis was conducted using SPSS version 15.0 and the level of significance was set at $p<0.05$.

RESULTS

Participation rates

Participation rates are not available for the pre-school sample, as these data were obtained from a statewide growth monitoring service, however as an estimate, this service achieves at least 75% pre-school child coverage state-wide. Data on 1005 pre-school children in 2006 and 1244 in 2009 were available.

Of the 44 primary schools invited to participate in the evaluation at baseline, 39 (88%) agreed and at follow-up 35 of 45 (78%) agreed. All children enrolled in year levels 5, 6 and 7 were eligible. At baseline, 1732 (51%) students consented to participate and at follow-up 1272 (45%) consented. Similar proportions of schools and students participated between intervention (INT) and comparison (COMP) sites, in both survey years.

Pre-school children

Data for pre-school children are shown in Table 1. Age, weight and height were not significantly different between 2006 and 2009 in either INT or COMP communities. In 2006, zBMI was significantly higher in INT compared with COMP children (p=0.034). There were significant reductions in both INT (-0.20, p=0.005) and COMP (-0.15, p=0.013) communities and the non-significant differential between communities resulted in no difference between communities at follow-up.

In terms of weight status (Table 1) there was a significant fall in the proportion who were overweight or obese between 2006 and 2009 in INT of 6.3% ($p<0.05$, $\chi 2$ test) and a non-significant fall in COMP of 3.7%.

Primary school children

Anthropometric data were available for 1626 and 1198 primary school children at baseline and follow-up respectively (Table 2).There were no significant differences in age, weight, height, BMI, WC, and BMI and WC z-scores between INT and COMP communities at either baseline or follow-up. There were no significant changes in zBMI in INT or COMP. However there was a significant decrease in WC z-score in INT sites (0.17) and a non-significant decrease in COMP sites (0.10). The differences over time between conditions was not significant (condition by time interaction (p=0.46)). The change in WC z-score relative to baseline equates to 24% improvement in INT, and 13% in COMP.

Based on BMI there were no significant changes in weight status categories in either INT or COMP, and changes were not significantly different between conditions. Similarly the changes in weight status category based on WC were not significant over time, nor significantly different between conditions. Considering an increase in thinness as an indicator of harm and using grade 2 thinness cut-points (Cole et al. 2007), less than 1% of children were identified as thin at baseline and follow-up in both INT and COMP conditions, with no change over time.

Changes in distribution of weight status

To determine any differential changes in weight outcomes between sub-groups of children, descriptive analysis was conducted across percentiles of BMI and WC z-scores. In INT, among those with zBMI above the 95th percentile (highest BMI), zBMI fell 0.10 between baseline and follow-up, compared with a group mean change of only 0.001 in the whole sample. In COMP, among those with zBMI above the 95th percentile (highest BMI), zBMI decreased by only 0.02 from baseline to follow-up, compared with a group mean change of 0.05 in the whole sample. These changes in zBMI in the top 5% equate to relative changes of -3.8% in INT and -0.8% in COMP. The equivalent figures for WC z-score were: INT, a decrease of 0.22 in the top 5% WC z-score compared with a decrease of 0.17 in the whole sample; and COMP, a decrease of 0.02 in the top 5% WC z-score compared with a decrease of 0.10 in the whole sample. This equates to relative changes of -7.9% in INT and -1.1% in COMP among the top 5% by fatness.

DISCUSSION

ewba aimed to reduce obesity in childhood in two geographically distinct, socio-economically disadvantaged communities. The quasi-experimental evaluation of intervention and comparison communities demonstrated a reduction in overweight and obese status among pre-school children, and improvement in WC among primary school children. Collectively these findings underscore the effectiveness of *ewba* in the two communities. Given that these improvements in intervention sites were larger than those in comparison sites (which account for secular changes in the population), the potential impact of the changes, although modest, are significant at the community level.

Using population data to extrapolate, the *ewba* intervention is estimated to have potentially reached more than 2,500 children 0 – 4 years; more than 5,500 children 5 – 14 years; and approximately 2,500 children 15 – 18 years, at a cost of approximately AU$188 per child.

Pre-school children

The differential changes among 4-5 year old children in INT included larger falls in zBMI (-0.05 difference) and prevalence of overweight and obesity (-2.6% difference). These improvements compare with the recent population trend in South Australia, where a small decline has been observed among pre-school children over the last few years (SA Health 2010). The results are also similar to a community-wide project targeting pre-school children aged 0-5 years in Geelong, Victoria, Australia (Romp and Chomp) [9]. Intervention children aged 3.5 years had a lower zBMI than those in the comparison communities (-0.04 CI: -0.7, -0.01, p<0.01) at follow-up. In addition, as observed in *ewba*, the prevalence of overweight and obesity was significantly lower in 2 (-0.06 CI: -0.12, -0.01, p<0.05) and 3.5 year olds (-0.08 CI: -0.14, -0.12, p<0.05). These findings are important to note in understanding the reach and impact of *ewba*. The *ewba* intervention targeted long day care, family day care and pre-school settings representing approximately 95% of pre-school children within the intervention communities. However, the response rate of state-wide data collection could not be determined, thus it is difficult to know what proportion of children are represented in the *ewba* evaluation samples and the extent, if any, of sampling biases.

The changes in both standardised BMI and weight status among pre-school children are encouraging, in terms of overall reduction and the differences observed between intervention and comparison sites. As the pre-school children in intervention sites were heavier at baseline than those in comparison sites the improvements observed are of considerable clinical relevance and may confer a significant benefit to future population health in these communities.

Primary school children

Among 10-12 year old children differential changes included a 0.06 decrease in WC z-score and 1.1 cm WC. Although WC z-scores of primary school children decreased in both INT and COMP, only improvements in INT children were statistically significant. BMI z-scores did not change significantly in INT or COMP, which is consistent with an indication of stabilisation or 'plateau' in children's weight over recent years (Olds et al.

2009). The lack of significant group by time interaction effects is likely to be related to sample size and statistical power to detect differences between INT and COMP.

The trend for improved WC in INT is encouraging considering that the baseline WC z-scores were higher at baseline, compared with baseline levels of BMI. This is a desirable outcome in primary school-aged children, given that WC is more highly correlated with body fatness in pre-pubertal children than BMI (Watts et al. 2008). The differential change in WC z-score in INT is noteworthy and may confer a significant benefit to future population health given the strong link between healthy weight distribution and cardio-metabolic health (Watts et al. 2008).

Similar small changes have recently been observed in other community-based obesity prevention interventions in Australia and internationally. The *Be Active Eat Well* intervention in Colac, Victoria, Australia showed statistically significant smaller increases in weight (mean: -0.11, 95% CI -0.21 to -0.01) and WC, (-3.14cm, -5.07 to -1.22) in the same children of primary school age, who were measured at baseline (2003-2004) and follow-up (2006)(Sanigorski et al. 2008b; Johnson et al. 2012).After one year of intervention of a community-wide program targeted at children in grades 1-3 in Massachusetts, USA (*Shape Up Somerville*), zBMI decreased by -0.1005 (p = 0.001, 95% CI, -0.1151 to -0.0859) in the intervention community compared with children in two control communities (mean age 7.6 +/- 1.0 year)(Economos et al. 2007).Similarly, in a community-based intervention with children aged 5 to 12 years in Otago, New Zealand (APPLE), zBMI was significantly lower in intervention than control children at 2 years, by a mean of 0.26 (95% CI: 0.21, 0.32) and WC was significantly lower at 2 y (-1 cm)(Taylor et al. 2007). Further follow-up 2 years after the intervention ended showed that mean zBMI remained significantly lower in intervention children. Intervention children were less likely to be overweight, but only in those who were present for the full intervention. There were no follow-up measurements of WC to reduce participant burden (Taylor et al. 2008).

Last, when considering effectiveness, it is important to note that the focus in the *ewba* intervention was community-wide multi-setting changes informed by socio-ecological theory, thus substantial efforts were made on policy and environmental change. This approach is likely to take longer to effect weight status than behaviourally-focused interventions (Swinburn et al. 2011; Johnson et al. 2012).

Adverse effects

It is encouraging to note that BMI and WC z-scores appeared to reduce more among the primary school students in the highest percentiles of z-scores in INT, compared to those in COMP. This may indicate that INT children with the highest BMI and highest WC z-scores (more overweight) experienced greater improvements, which was in contrast to the changes in COMP. The 4.2% fall in weight status based on WC in INT suggests that some reduction in unhealthy weight distribution occurred as a result of the *ewba* intervention. The absence of any change in the proportion of children identified as thin supports the intended goal of the intervention (primary prevention of unhealthy weight gain). These findings are in contrast to a similar recent intervention evaluation that showed beneficial changes to BMI only among children who were *not* overweight at baseline (Taylor et al. 2008).

Equity

Although detailed demographic data were not collected in this study, it is important to note that the measured improvements in weight status occurred within the context of socio-economically disadvantaged communities. The burden of overweight and obesity is disproportionally high among the socioeconomically disadvantaged (Australian Bureau of Statistics 2010), highlighting the potential for this intervention approach to address social disparities in health in Australia.

Sustainability

Longer term follow-up has not yet been conducted among the same INT and COMP communities and therefore the sustainability of these changes beyond the three-year assessment is unknown. However given that policy and environmental interventions (including workforce development) were implemented it is likely that the observed changes are sustainable.

There is now some evidence (Sanigorski et al. 2008b; de Silva-Sanigorski et al. 2010b; Taylor et al. 2008) in support of community-wide approaches in reducing the prevalence of childhood obesity, but it is not yet known whether the community development approach taken in South Australia, with resources shared across metropolitan and regional/rural sites operating in two different health services, was sufficient to embed sustainable changes within local systems (e.g. education, care). Further evidence will be generated in the evaluation of the Obesity Prevention and Lifestyle (OPAL) initiative, which follows on and scales up from the *ewba* intervention, being implemented in 20 South Australian communities to date (SA Health 2012).

Strengths and weaknesses

A number of strengths of this evaluation reduce the risk of bias. Regarding study design, for this community-based intervention the most pragmatic evaluation design was a quasi-experimental study with non-randomised matched-comparison communities, which allowed interpretation of findings against secular changes. Matching COMP sites according to demographic data minimised selection bias and selecting geographically separated COMPA sites minimised contamination. Confounding is unlikely as there were no clinically important or statistically significant differences at baseline between INT and COMP children. Further, the response rates achieved were very good compared with similar evaluations (Wilson et al. 2010; Sanigorski et al. 2008b), so the sample measured is more likely to be representative of the population of interest, and provides confidence in our estimates.. The objective anthropometric assessments showed high accuracy and reliability in measurement for the primary school children.

Due to the ‘real world’ nature of this intervention and pragmatic approach to evaluation, limitations in the evaluation design exist. Measurements were taken on cross-sectional samples in the same communities at two time points, rather than upon specific individuals and as a result, a limitation of this evaluation study is that the changes observed cannot be solely attributed to the *ewba* intervention. Contextual factors that may have impacted upon the interpretation of these findings (such as other healthy weight initiatives within South Australia) were explored and described (Pettman et al. 2010) but the level of 'background' intervention was assessed as no more profound in COMP than INT sites.

Conclusions

These results from evaluation of a community-based childhood obesity prevention intervention in two geographically distinct, disadvantaged communities suggest a modest impact of the *ewba* intervention.. The four-year community development intervention focused upon increasing healthy eating and physical activity behaviours through a range of children's settings using multiple strategies. Encouragingly, and in line with other similar complex community-level interventions, small but important improvements in children's weight status at three year follow up were observed.

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