Effectiveness of current interventions in obese New Zealand children and adolescents

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ABSTRACT

AIMS: To determine the effectiveness of current interventions in New Zealand in obese children and adolescents accessing either a standard model of care (medical input alone or with the addition of dietitian and physical activity input), or one of the country's long-standing multi-disciplinary intervention programmes.

METHODS: Data were recorded over approximately 2.1 years of intervention from 290 patients across four centres in New Zealand, who manage obese and overweight children and adolescents aged 3–16 years in paediatric clinics.

RESULTS: There was a small but significant annual reduction in BMI SDS irrespective of the nature of intervention (-0.15 overall). There was no significant difference in BMI SDS between interventions. The extent of BMI SDS reduction decreased with increasing age at first outpatient attendance (p=0.0006). BMI SDS reduction was unaffected by ethnicity or gender.

CONCLUSIONS: Mild reductions in BMI SDS are achievable in children being referred to and managed for obesity by a range of models. It is important that paediatricians are proactive in identifying and addressing obesity with families. Further research is required to evaluate multi-disciplinary intervention programmes, and how their effectiveness can be increased, given their recognised benefits in improving cardiovascular and metabolic profile, as well as BMI SDS.

Introduction

Childhood obesity leads to adult obesity, and its co-morbidities. Longitudinal studies from the 1970s show that approximately one third of obese preschool children become obese adults, and about half of obese school-age children remain obese as adults.[1] This finding has not changed with time; a 1996 adolescent cohort in the US found 37% of obese male and 51% of obese female adolescents (body mass index (BMI)>95th percentile) were severely obese (BMI>40kg/m²) by 30 years of age, compared with <5% of normal-weight teenagers.[2]

Growth during childhood is a non-linear process with increases in weight and adiposity not always occurring simultaneously.[3] As a consequence BMI varies through infancy, childhood and puberty making it an unsatisfactory measure of adiposity when assessing children of varying ages.[4–6] BMI standard deviation score (SDS), which corrects for age and gender, is a better measure for assessing change in adiposity over time.[4,5] Despite its inherent inaccuracy, to date most longitudinal studies have focussed predominantly on change in BMI.

In New Zealand, there are limited data sets available that allow BMI progression during childhood to be examined. The available data show a marked difference between the growth trajectories of Māori and New Zealand European children.[7] The most comprehensive longitudinal study to date is the Dunedin Multi-Disciplinary Health and Development Study, a cohort

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of children born in Dunedin in 1972–73, followed up at two yearly intervals from age 3–16 years, then at 18, 21, and 26 years. The cohort was under-representative of non-European ethnicities with approximately 3% of the cohort being of either Māori or Pacific ethnicity.[8] BMI was tracked with age, and for all groups, BMI became more stable with increasing age. At 18 years of age, the value of the 98th centile was close to the World Health Organisation (WHO) criteria defining obesity in adults, and it was recommended that this cut-off could be used to describe obese children and adolescents in the New Zealand population.[9]

With regard to tackling childhood and adolescent obesity, the 2009 New Zealand Ministry of Health Guidelines recommended a multi-disciplinary approach, working with family/whānau to address food habits, activity and behaviour.[10] This approach is supported by recent meta-analyses, which show that lifestyle interventions compare favourably with other approaches to childhood obesity.[11,12] However, it is unclear if this approach works in the New Zealand context, and adoption of multi-disciplinary models and intervention in general has been variable nationally.[13] Presently, for most children and adolescents in New Zealand, the available services are limited, with few centres running multi-disciplinary services. Those children that do see a paediatrician are likely to be able to access medical assessments for their weight, dietitian advice, and, if in an area where it is offered, Green Prescription 'Active Families' (described below) through their local regional sports trust, or equivalent physical activity programme.

While it is clear that most obese children continue to gain weight, what remains unclear is what the natural progression is over time. With no relevant longitudinal cohort able to answer this question for the child and adolescent age group, an alternative approach was sought. This collaborative multi-centre audit aimed to describe what the progression of weight change is during follow-up for those obese children and adolescents accessing either a 'standard' model of care in New Zealand (either medical input alone or with the addition of dietitian and/or physical activity input), or one of the country's long-standing multi-disciplinary intervention programmes.

Methods

Entry criteria were children and adolescents aged 3 to 16 years that were identified as having a BMI>98th centile (WHO definition of obese), or >91st centile (over-weight) with significant weight-related co-morbidities. Data were collected from four district health board (DHB) regions across New Zealand (Midcentral, Northland, Taranaki and Waikato) together serving a paediatric population of 168,786.[14] Entry was defined as first contact in clinic. Approval from the National Ethics Advisory Committee to treat this study as an audit was obtained.

The data were anonymised: dates of birth were collected for age calculations, and data sheets were password protected. For each patient, ethnicity, gender, and height and weight recordings taken at medical assessments spanning an average of 2.1 years from baseline were collected. BMI, BMI percentile, and BMI SDS were calculated using UK Cole normative data[15] on the uploadable KIGS auxology software (Pfizer Endocrine Care™).

Data were described by age, gender, and ethnicity. The types of intervention received by each patient were recorded. The nature of obesity intervention varied depending upon what was available at the different centres, and what patients and their families accepted in terms of referral. Some patients presented with weight as the primary concern; others were being seen for other medical conditions where obesity was subsequently identified.

Intervention included one of the following: i) 'standard' models of care—medical follow-up by a paediatrician at regular intervals with no dietitian input (usually because input was declined); ii) medical follow-up by a paediatrician and dietitian input at regular intervals; iii) medical follow-up/ dietitian input and Green Prescription (GRx) 'Active Families' input; or iv) a multi-disciplinary intervention programme, that was offered at one centre. For all centres apart from one, the follow-up was by a paediatrician with an interest in obesity; for the other centre, results were collected across the whole paediatric department's caseload. The GRx 'Active Families' programme is implemented by 14 DHBs across New Zealand and delivered by regional sports trusts. It is a family/whānau based programme that attempts to encourage healthy lifestyle change in children, adolescents and their families at a community level, addressing both physical activity and nutrition in weekly sessions for up to 12 months. Its goal is to achieve persistent healthy lifestyle change in the participant and their family/whānau. The multi-disciplinary intervention programme involved input from a paediatrician, healthy lifestyles co-ordinator, dietitian, psychologist, and 'Active Families' co-ordinator. The intervention involved 8 group sessions at weekly intervals after baseline assessment, with a goal of follow-up for 24 months.

Statistical analyses

Data were analysed in Minitab (v.16, Pennsylvania State University, State College, PA, USA) and SAS v.9.3 (SAS Institute, Cary, NC, USA). Demographic characteristics were compared using one-way ANOVA. Multiple variable linear regression models were constructed in SAS v.9.3. Age, duration of follow-up, and ethnicity were included as independent variables in all models. Regression models also adjusted for the baseline value (at entry) of the outcome response to gain statistical efficiency and power (ie, baseline data were included in the model as covariates). All statistical tests were two-tailed. Demographic data are presented as means ± standard deviations (SD), while other data are model-adjusted means (estimated marginal means adjusted for the confounding factors in the models), with associated 95% confidence intervals.

Results

Demographics

A total of 290 children and adolescents (50% boys) aged 10.0 ± 2.8 years (range 3.4–16.1 years), with a mean BMI percentile of 99.6% (range 92.6–100.0%), and mean BMI SDS of 3.16 ± 0.72 (range 1.45–5.79), were captured for inclusion. Dates of collection spanned from October 2003 to October 2012 across the centres. There were no exclusions. Duration of follow-up analysed was 2.1 ± 1.1 years (range 0.2–7.5 years).

Type of intervention

Half of the participants (n=145) underwent multi-disciplinary intervention at one centre, while the other half (n=145) received more 'standard' models of care at the other three centres (described above, see Table 1). There were variations in the ethnicity of participants undergoing the different interventions (p=0.005), with a smaller proportion of New Zealand Europeans undergoing multi-disciplinary intervention or medical only interventions (Table 1). Participants in the multi-disciplinary intervention group were older, had greater BMI at entry, and were followed for a shorter period of time than those from other interventions (Table 1). Notably, the change in BMI SDS was similar irrespective of intervention type (p=0.64). There was a significant reduction in BMI SDS over time with both multi-disciplinary intervention and 'standard' models of care (-0.15 overall, see Table 2).

Effects of age, sex, ethnicity, and intervention type

The extent of BMI SDS reduction was significantly affected by participant's age at entry (p=0.0006). Thus, the older the child was, the lower the observed reduction in BMI SDS over time. This effect did not vary with gender (p=0.66), with males and females having an overall reduction in BMI SDS of -0.16 and -0.14 per annum respectively (both p<0.0001, see Table 3). Of note, there was no age difference in presentation between boys and girls across the cohort (p=0.35), and duration of follow-up was similar (~2.1 years; p=0.76, see Table 3).

A reduction in BMI SDS was observed in all ethnic groups, with an overall reduction of BMI SDS of -0.17 observed in New Zealand Europeans (p<0.0001), -0.15 in Māori/Pacific (p<0.001), and -0.16 in all other ethnicities (p=0.075, Table 3). However, Māori/Pacific had a greater average BMI SDS on entry to the programme compared with Asian/other (p=0.007), and New Zealand Europeans (p<0.0001). Despite a similar age at presentation, New Zealand Europeans were followed up for longer than participants from other ethnicities (p<0.01, see Table 3).

Table 1: Demographics of study cohort at the time of study entry according to type of intervention. Where appropriate, data are means ± standard deviations.

Variable	Medical	Medical & Dietitian	Medical & Dietitian & Active Families	Multi-disciplinary	p-value
N (% of total cohort)	23 (8%)	75 (26%)	47 (16%)	145 (50%)	
Gender (n (%) males)	17 (74%)	37 (49%)	25 (53%)	66 (46%)	0.077
Ethnicity (n (%))					0.005
New Zealand European	11 (48%)	47 (63%)	32 (68%)	63 (43%)	
Māori	10 (44%)	25 (33%)	7 (15%)	65 (45%)	
Pacific	1 (4%)	1 (1%)	1 (2%)	6 (4%)	
Asian/Other	1 (4%)	2 (3%)	7 (15%)	11 (8%)	
Age (years)	8.5 ± 2.8	9.3 ± 3.3	9.6 ± 3.0	10.7 ± 2.1	<0.0001
BMI SDS	3.39 ± 0.9	3.14 ± 0.83	3.08 ± 0.83	3.16 ± 0.83	0.40
BMI (kg/m²)	27.8 ± 5.8	27.5 ± 4.6	28.2 ± 6.1	30.7 ± 6.0	0.0004
Duration of follow-up (years)	2.5 ± 1.2	2.7 ± 1.1	2.3 ± 1.3	1.7 ± 0.7	<0.0001

Table 2: Changes in body mass index (BMI) and BMI standard deviation scores (SDS) according to type of intervention. Data are means and 95% confidence intervals adjusted for confounding factors (including patient's age and duration of follow-up) in the multivariate models.

Variable		Medical	Medical & Dietitian	Medical & Dietitian & Active Families	Multi-disciplinary	p-value
N		**23**	**75**	**47**	**145**	
Δ BMI SDS	Overall	-0.17 (-0.33–-0.01)*	-0.14 (-0.23–-0.04)**	-0.22 (-0.33–-0.10)***	-0.13 (-0.20–-0.07)***	0.64
	per year	-0.08 (-0.17–0.01)	-0.08 (-0.13–-0.03)**	-0.14 (-0.20–-0.07)****	-0.07 (-0.11–-0.03)***	0.35
Δ BMI (kg/m²)	Overall	2.10 (0.94–3.25)***	1.89 (1.23–2.56)****	1.14 (0.33–1.94)**	2.01 (1.53–2.49)****	0.30
	per year	0.96 (0.26–1.66)**	0.85 (0.45–1.25)****	0.36 (-0.12–0.85)	0.86 (0.57–1.15)****	0.31

*p<0.05, **p<0.01, ***p<0.001, and ****p<0.0001 for a change from baseline.

Table 3: Demographic characteristics and changes in body mass index (BMI) and BMI standard deviation scores (SDS) over time according to gender and ethnicity. Demographic data are means ± SD; other data are means and 95% confidence intervals adjusted for other confounding factors (including patient's age and duration of follow-up) in the multivariate models.

		GENDER		ETHNICITY		
Variable		**Males**	**Females**	**New Zealand European**	**Māori/Pacific**	**Asian/Other**
N		145	145	153	116	21
BMI SDS		3.29 ± 0.77	3.03 ± 0.65¥¥	2.95 ± 0.65	3.46 ± 0.71††††	3.02 ± 0.80‡‡
BMI (kg/m²)		29.2 ± 5.6	29.3 ± 6.1	27.9 ± 5.0	31.2 ± 6.3††††	28.7 ± 5.7‡
Age at baseline (years)		9.9 ± 2.7	10.1 ± 2.8	10.0 ± 2.7	9.8 ± 2.7	10.5 ± 3.0
Duration of follow-up (years)		2.1 ± 1.1	2.1 ± 1.0	2.3 ± 1.2	1.9 ± 0.9††	1.6 ± 0.6††
Δ BMI SDS	Overall	-0.16 (-0.23–-0.10)****	-0.14 (-0.20–-0.08)****	-0.17 (-0.25–-0.10)****	-0.15 (-0.24–-0.07)***	-0.16 (-0.33–0.02)§
	Per year	-0.10 (-0.13–-0.06)****	-0.07 (-0.11–-0.03)***	-0.10 (-0.14–-0.06)****	-0.08 (-0.13–-0.03)***	-0.08 (-0.18–0.01)§
Δ BMI (kg/m²)	Overall	1.86 (1.37–2.36)****	1.83 (1.33–2.33)****	1.68 (1.17–2.18)****	1.94 (1.33–2.55)****	1.77 (0.55–2.99)**
	Per year	0.71 (0.44–0.98)****	0.86 (0.58–1.14)****	0.66 (0.36–0.97)****	0.88 (0.51–1.24)****	0.75 (0.01–1.49)*

¥¥p<0.01 for males vs females; §p<0.08, *p<0.05, **p<0.01, ***p<0.001 and ****p<0.0001 for a change from baseline; ††p<0.01 and ††††p<0.0001 for comparison with NZ European; ‡p<0.05 and ‡‡p<0.01 for Asian/Other vs Māori/Pacific.

Discussion

This multi-centre audit showed that any form of obesity intervention appears to be beneficial, irrespective of ethnicity and gender. This is encouraging, given that, in a 2013 Australian on-line survey, only 20% of paediatricians felt they could make a difference to an obese child's weight.[16] It has been argued that a statistical improvement in BMI SDS is not the same as a *clinically significant* improvement in these individuals, as in most cases, they move from being obese to slightly less obese. However, the Cochrane Collaboration review of interventions for treating obesity in children concluded that combined behavioural lifestyle interventions compared to 'standard' care can produce significant and clinically meaningful reductions in overweight children and adolescents.[11] In a recent meta-analysis, lifestyle interventions that achieved a BMI SDS reduction of -0.1 led to significant improvements in low-density lipoprotein cholesterol, triglycerides, fasting insulin and blood pressure up to 1 year from baseline, therefore improving cardiovascular and metabolic outcomes in these individuals.[12] However, it is important to acknowledge that, depending on age and severity of obesity, the ultimate goal, if severely obese, is to lose weight.

We were surprised that type of intervention did not affect outcome. The fact that a multi-disciplinary intervention programme did not outperform medical follow-up may be explained by two factors. Firstly the multi-disciplinary cohort were older, and increasing age was found to lead to a smaller BMI SDS reduction overall. The BMI SDS was greater at entry, which may have also impacted on the degree of BMI SDS reduction. Almost half of the multi-disciplinary cohort was either Māori or Pacific peoples, which may have contributed to outcomes given the known differences in BMI between Māori and New Zealand European cohorts with increasing age.[7] There were also differences in participant duration of follow-up, but it is unclear if this affected results. It is important to note that the multi-disciplinary intervention programme included in this study was as successful as those seen in recent meta-analyses of intervention programmes.[12]

Multi-disciplinary intervention programmes for child and adolescent obesity have been shown to lead to weight loss in the short to medium term in numerous systematic reviews.[11,12,17-20] A recent meta-analysis including 12 studies reporting BMI and 7 studies reporting BMI SDS showed a pooled BMI reduction of 1.25 kg/m^2 (95% CI 0.32–2.18) and a BMI SDS reduction of 0.10 (95% CI 0.02–0.18) compared with control groups.[12] However, the studies were of varying quality, and often with minimal long-term follow-up. BMI has been included in this paper to demonstrate that whilst BMI SDS may fall, BMI often continues to climb over time with increasing age. Whilst multi-disciplinary intervention programmes are important for the management of child and adolescent obesity, they are labour-intensive for staff and participants, and costly. If participants continue to gain large amounts of weight, and do not improve cardiovascular outcome or long-term metabolic risk, then the benefit of the programme would have to be questioned. As custodians of the future healthcare system, there is a need to be mindful of cost-effectiveness, and models of cost-effectiveness analysis that can incorporate BMI SDS as well as other agreed outcomes are required.

The optimal outcome measure to assess multi-disciplinary intervention programmes remains unclear. However, most programmes that have been included in meta-analyses have either used BMI or BMI SDS as the primary outcome.[11,12,18] Given the changes in BMI over childhood and adolescence, as is demonstrated in this study, BMI as an outcome in isolation can be misleading. It has been argued therefore that BMI SDS should be used when comparing interventions. Waist-height ratio (WHtR) is significantly better in predicting *metabolic syndrome* when compared with BMI SDS,[21] and WHtR has been shown to be superior for assessing adiposity than BMI in puberty.[22] It is therefore recommended that WHtR is considered an additional measure to BMI SDS when assessing outcome of intervention programmes. Waist circumference data were not available for the children included in this audit.

There is concern that extreme percentiles for BMI-for-age have a level of inaccuracy, and therefore high BMI values should be expressed as a percentage of the 95th percentile for heavier children.[23] There may be a shift in future towards reflecting outcome data using BMI as a percentage of the 95th percentile for age for interventions, for example the recent RESIST trial.[24] However, there has not been a universal shift towards this method of reporting outcome to date.

This study confirms the importance of intervening with obesity early, as the change in BMI SDS in association with any intervention decreased with increasing age of presentation to clinic. This is consistent with previous findings in meta-analyses, where BMI SDS reductions in children receiving intervention programmes were greater than BMI SDS reductions in adolescents.[12]

Limitations of this study were the heterogeneous sample and the potential variability in measurement technique at varying centres, given its retrospective nature. However, this was somewhat mitigated by the collection of individual measurements over time. We are not able to describe the natural weight trajectory in an untreated obese population over time or compare with a control group as this was not available, but New Zealand's contemporary longitudinal cohort study 'Growing Up in New Zealand' (www.growingup.co.nz) will be able to achieve this in a more representative population of the country's ethnic demographic.[25] It was not possible to ascertain from our data whether input from a paediatrician or a dietitian with a special interest in obesity affected outcome. This is a question that would be useful to ask in future research.

In conclusion, this study has shown that, in a heterogeneous paediatric sample, even medical follow-up alone can make a beneficial difference to BMI SDS over time, irrespective of gender or ethnicity. Paediatricians need to be proactive with regard to identifying and addressing child and adolescent obesity. Further research evaluating multi-disciplinary intervention programmes for obesity in children and adolescents in New Zealand is required, especially regarding how to improve outcome of these programmes for ethnic and socioeconomic subgroups with the highest prevalence of obesity.

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