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Issues in evaluating the costs and cost-effectiveness of Cognitive Behavioural Therapy for Overweight/Obese Adolescents

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Introduction

Economic evaluation is the systematic assessment of the costs and consequences of alternative courses of action. In health and healthcare, the results can be used to inform clinicians and policy makers about the relative cost-effectiveness of options under consideration [1]. Many economic evaluations are undertaken alongside randomised controlled trials (RCTs); the advantages of this approach are that i) prospective, accurate data can be collected on costs and effects and ii) appropriate outcome measures for use in economic evaluation can be chosen. The outcome of an economic evaluation is usually described as a ratio of the costs and effects – often called the incremental cost-effectiveness ratio (ICER). The ICER is determined by calculating the differences in the costs and effects of both intervention and control groups and dividing the former by the latter. In designing an economic evaluation, the important questions to resolve are: which costs should be included and which outcome measures are most appropriate for estimating the cost-effectiveness ratio?

In 2005, the Australian Technology Network of Universities funded the Centre for Metabolic Fitness (CMF) through a competitive, peer-reviewed process. The aims of the centre are to develop and evaluate diet and exercise interventions to counteract metabolic syndrome and assess their acceptability by target community groups. Metabolic syndrome is a cluster of metabolically determined risk factors associated with obesity (e.g. hypertension, impaired blood glucose etc). A number of collaborative projects have been developed within the centre, one of which is the CHOOSE HEALTH project. As part of this project, the effectiveness of cognitive behavioural therapy (CBT) as an intervention for overweight or obese adolescents has been trialled at the University of RMIT by Leah Brennan and the University of South Australia by Margarita Tsiros, as part of their post-graduate studies[1]. Subsequently, it has been decided to add an economic component to this work. Trials of the effectiveness and cost-effectiveness of different means of delivering cognitive behaviourally based weight management programs are planned[2].

This paper reports the results of investigations into the two questions which need to be addressed prior to undertaking a formal economic evaluation of the CHOOSE HEALTH program: i) what costs should be included and ii) which measures of outcome are suitable for estimating an ICER in this context. The paper is organised in four sections. Following the introduction (section 1) and brief descriptions of the background to and context in which the program was planned (section 2), details of the RMIT trial design and results are provided in section 3. In the final section (section 4), a cost model is presented and the implications of the outcomes used in the initial trials of the effectiveness are discussed in relation to designing a prospective economic evaluation of the CHOOSE HEALTH program.

[1] The original trial of the CHOOSE HEALTH program was done as part of Leah Brennan's PhD work prior to the formation of the CMF. The CMF was involved in the project managed by Margarita Tsiros and a subsequent trial at RMIT

Background

Overweight and obesity in children

There is concern about the increase in overweight and obesity amongst children in Australia. In Australia, the National Health and Medical Research Council (NHMRC) guideline on overweight and obesity makes a number of recommendations relating to children which are important to note [2]. First, Body Mass Index (BMI) measurement in children and young people should be related to the 2000 charts of Cole et al. to give age- and gender-specific information [3]. This allows tracking of both individuals and cohorts over time, accounting for the natural trend in height and weight as children physically mature. Also, as the figures are fixed at a time point, it also allows comparison between current and previous cohorts of children. Second, it defines overweight as an individual with a BMI above the 85th percentile, and obesity as an individual with a BMI above the 95th percentile. Using Australian Bureau of Statistics figures [4], 5% (i.e. at or above the 95st percentile) equates to 244,000 individuals below the age of 18. Indeed, the true figure is likely to be slightly higher as more than 5% of the current population exceed the 95st percentile from previous time points.

Cognitive behavioural therapy (CBT)

Cognitive Behavioral Therapy (CBT) is a psychotherapy based on cognitions, assumptions, beliefs, and behaviors, with the aim of influencing negative emotions that relate to inaccurate appraisal of events. The general approach, developed out of behavior modification, Cognitive Therapy and Rational Emotive Behaviour Therapy, has become widely used to treat various kinds of neuroses and psychopathology, including mood disorders and anxiety disorders. The particular therapeutic techniques vary according to the particular kind of client or issue, but commonly include keeping a diary of significant events and associated feelings, thoughts and behaviors; questioning and testing cognitions, assumptions, evaluations and beliefs that might be unhelpful and unrealistic; gradually facing activities which may have been avoided; and trying out new ways of behaving and reacting. Relaxation and distraction techniques are also commonly included. CBT is widely accepted as an evidence- and empiricism-based, cost-effective psychotherapy for many disorders and psychological problems. It is sometimes used with groups of people as well as individuals, and the techniques are also commonly adapted for self-help manuals and, increasingly, for self-help software packages. The objectives of CBT typically are to identify irrational or maladaptive thoughts, assumptions and beliefs that are related to debilitating negative emotions and to identify how they are dysfunctional, inaccurate, or simply not helpful. This is done in an effort to reject the distorted cognitions and to replace them with more realistic and self-helping alternatives.

Behavioural therapy and cognitive behavioural therapy incorporating changes to dietary and exercise behaviour, has been shown to result in greater weight loss than regular diet and exercise interventions [5]. However, the findings regarding longer-term effects of CBT on weight are less conclusive [6]. In addition, recent improvements in the CBT model are expected to result in better maintenance of weight loss also. CBT can be used successfully in a range of settings, in either individual or group mode and can be delivered by a range of health professionals. Therefore, combined with the scale of the population for whom clinical interventions might be considered under the NICE-type

approach, it is worthwhile investigating its effectiveness and cost-effectiveness more formally.

The CHOOSE HEALTH program

CHOOSE HEALTH is a cognitive behaviourally based weight management program for adolescents developed and trialled by Leah Brennan as part of her PhD studies. The specific aims of the study were to (i) examine the impact on body composition; (ii) examine the impact of the intervention on cardiovascular fitness and resting energy expenditure; and (iii) to explore the impact of the intervention on the eating and physical activity habits of overweight and obese adolescents.

The initial trial of CHOOSE HEALTH

Design

The original CHOOSE HEALTH program designed by Brennan consisted of 12 sessions plus 10 follow-up sessions; two clinic sessions and eight phone calls. A detailed description of the program can be found in Appendix 1. An initial trial was conducted with 63 overweight or obese adolescents. As can be seen in

Figure 1, individuals were first assigned to either CBT alone or CBT preceded by Motivational Interviewing (MI)[3] and then were randomly assigned to receive the intervention immediately or to be placed on a waiting list (control). MI, developed in the treatment of treating alcoholism and now used widely in the drug and alcohol field, aims to assist the individual to become ready for change [7] . MI has been used in conjunction with CBT to increase treatment initiation and completion rates and to improve treatment outcomes [8]. However, the use of MI in the treatment of overweight and obesity has received very little attention in the theoretical and empirical literature [9]. Thus, the CBT + MI can be regarded as a comparator group to CBT whilst the true control group consisted of those assigned to a waiting list for CBT. The adolescents in the control group participated in all pre-treatment assessments; they received no CBT initially but were able to access the program once the first cohort had completed 12 sessions. Potential participants and their families were recruited by advertisement.

[3] The first half of the participants were assigned to CBT alone; the second half to CBT + MI

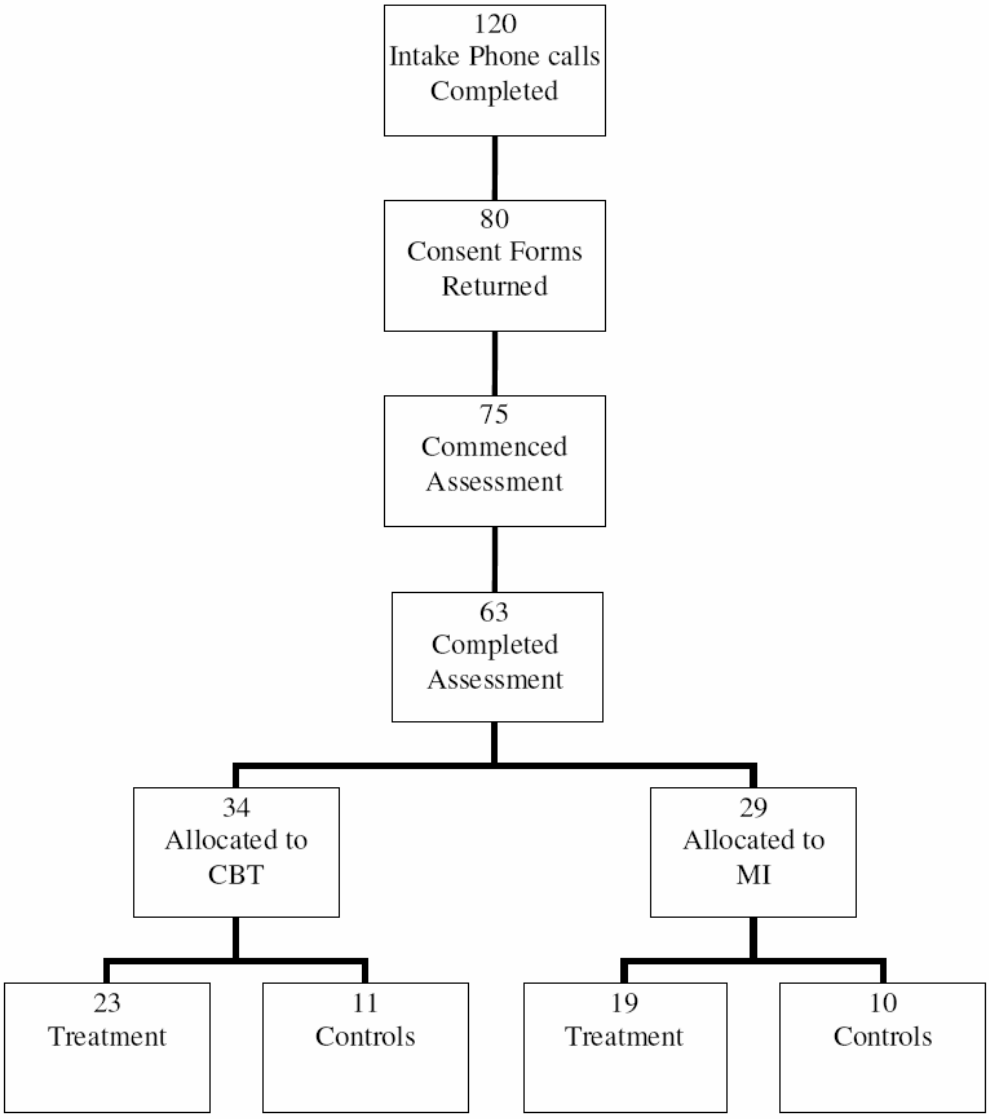

Figure 1: Recruitment and Allocation

Results

Participation in a motivational interview prior to the cognitive behavioural intervention did not influence treatment outcomes; therefore, the results for CBT + MI and CBT alone have been combined.

The results indicated that the intervention improved self-reported eating behaviour, physical activity and sedentary activity outcomes as well as laboratory measured fitness and body composition outcomes (particularly percentage of body fat). The main results of the effectiveness analysis is illustrated in Table 1. Final outcomes measured were BMI, BMI-for-age percentile and BMI-for-age z score. The BMI-for-age z score is a measure of the standard deviation away from aged standardised mean BMI. It is considered one of the most appropriate measures of weight in children and adolescents because it accounts for the wide, natural variation in growth. To interpret BMI-for-age z scores, it is necessary to understand that 0 is equal to normal weight. The NHMRC guideline on obesity indicates that the 90th and 95th percentile were the cut-offs for overweight and obesity, respectively. If we assume a normal distribution, the 90th percentile is 1.28 standard deviations from the mean, and the 95th percentile is 1.65. Using this classification, the average adolescent in the CHOOSE HEALTH trial was obese on entering the trial, and remained so following the intervention, albeit at a lower z-score.

Overall, the group average BMI-for-age z score and BMI were statistically significantly different. The results for BMI-for-age z score show that pre-treatment, the BMI of participants in the treatment and control groups was similar, although overall and for girls, the treatment group was, on average, less obese than the control group, although pre-treatment differences between the groups was not statistically significant. Following the intervention, the results show that the treatment group experienced a greater reduction in BMI than the control group; the BMI-for-age z score for the treatment group fell by 0.13 while the control group gained 0.03. The pattern is repeated for both girls and boys.

Although these measures of weight are the most suitable to include in an economic evaluation, weight was not the only outcome measured. Treatment resulted in improved body composition at post treatment and sustained or improved body composition following maintenance. Despite reductions in weight and body fat, lean body mass was not affected by the intervention, thus, treatment did not detrimentally effect linear growth and lean body tissue.

	Total Sample			Males			Females		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
BMI (kg/m^2)									
Pre	43	32.59	4.38	20	31.69	4.81	23	33.24	4.13
Treatment	29	32.48	4.6	13	31.63	4.73	16	33.18	4.52
Control	14	32.59	4.38	7	31.81	5.35	7	33.37	3.39
Post	43	32.24	5.20	20	31.81	6.06	23	32.60	4.44
Treatment	29	31.58	5.13	13	31.03	5.38	16	32.03	5.04
Control	14	33.59	5.28	7	33.27	7.38	7	33.27	7.38
BMI-For-Age Percentile									
Pre	43	96.61	5.08	20	97.85	2.34	23	97.55	2.27
Treatment	29	97.54	2.52	13	97.81	2.48	16	97.32	2.60
Control	14	98.01	1.78	7	97.91	2.32	7	98.10	1.21
Post	43	96.61	5.08	20	97.12	3.46	23	96.17	6.20
Treatment	29	95.87	5.95	13	96.68	3.89	16	95.22	7.28
Control	14	98.15	1.81	7	97.96	2.52	7	98.34	0.82
BMI-for-Age Z-Score									
Pre	43	2.12	.35	20	2.18	.381	23	2.07	.32
Treatment	29	2.10	.36	13	2.17	.387	16	2.04	.34
Control	14	2.16	.33	7	2.18	.402	7	2.14	.26
Post	43	2.04	.46	20	2.1	.46	23	1.99	.46
Treatment	29	1.97	.50	13	2.04	.48	16	1.92	.52
Control	14	2.19	.32	7	2.22	.44	7	2.17	.19

Table 1: Descriptive Statistics for BMI, BMI-For-Age Percentile, and BMI-For-Age Z-Score

Economic analysis

As CHOOSE HEALTH is a labour intensive intervention, it seems worthwhile to investigate its cost-effectiveness for this group; that is, to examine the extent to which the costs expended are worth the benefits gained. However, as indicated above, some initial work is required before an economic evaluation can be conducted alongside future trials cognitive behavioural weight management interventions, particularly in relation to determining the perspective of the analysis and the outcome measure(s) to be used.

Cost model

The detailed description of the program (Appendix 1) was used to estimate the costs of the program which consisted of 12 sessions. The results are reported in Table 2. In the

table, research-specific costs are presented in italics. The costs are based on a salary for a Psychologist, Grade 2, Year 1. On-costs of 30% have been included and time for preparation has been allowed for. In a non-research setting, the CHOOSE HEALTH program would cost approximately $700 per participant. The cost for MI was essentially the same as for CBT. Those randomised to CBT received either an assessment interview or an MI. so in this instance MI acted as a comparator. In the trial, the actual control was a waiting list for CBT.

Table 2: Cost per participant of the CHOOSE HEALTH program

Period	Cost item	Unit cost ($)	Total (italics if research setting only)
Intake	15 minute questionnaire (research setting only)	40.04/hour	*10.01*
Assessment	Assessment interview (1 hour)		40.04
Treatment	Monitoring instructions (30 minutes, research setting only) 12 sessions (1 hour/session)		20.02 480.48
Maintenance	2 sessions (1 hour) 8 phone calls (15 minutes)		80.08 80.08
			700.70 (*710.71*)

The costs calculated were from the perspective of the CHOOSE HEALTH program alone. The appropriate perspective for an economic evaluation depends on the setting, but there is a strong argument that costs should be counted irrespective of where they accrue (also known as the societal perspective) [10]. In the case of the CHOOSE HEALTH program, this would include the direct costs of the program (as has been calculated here), direct costs to the participants (e.g. does the person spend a significant amount of time and money in receiving an intervention or attending a program?), any costs associated with changes in productivity (does the program allow people to be more productive in the economy, for example reduce their level of sick leave?) and other government costs (e.g. does this program change expenditure in education?). The importance of the issue of perspective is two-fold. First, costs incurred outside the health sector can often be significant, and a reduction in them might form a key output for the evaluation of a health program. Second, an inconsistent approach to the perspective employed might lead to erroneous conclusions regarding the relative costs of components of a program, the changing costs of a component over time, or both.

Appropriate measures of effect

Economic evaluations typically include a long-term measure of effectiveness such as number of lives saved, number of life years saved or number of quality-adjusted life years (QALYs) gained. This makes the resulting ICER comparable across interventions thus informing decisions about which technologies or treatments represent value for money. However, many economic evaluations also include clinical measures of effectiveness such as the ones measured in this trial because such measures are useful for practitioners

to compare the effectiveness of interventions in ways meaningful to them. However, it is important to realise such clinical measures cannot readily be used in an ICER.

To illustrate this point, an ICER can be calculated from the costs and effects of CBT plus or minus MI compared with the waiting list control group. The results of such a calculation indicate that the ICER would be described in terms of cost per unit decrease in z-score (calculated as $6,370 ($700.70/0.11)). Whilst it may be possible for practitioners to judge whether spending $700 to achieve this level of improvement amongst obese adolescents represents good value for money, the result is not useful in a broader decision making context as it cannot be compared with the results from trials of other interventions, particularly outside of the field of overweight and obesity.

Even if a meaningful ICER could be calculated (e.g. the cost/QALY gained of the CHOOSE HEALTH program), it must be judged against a threshold – a cost/outcome that indicates society's willingness to pay. It is rare for such thresholds to be set in an explicit fashion; if it is set explicitly, the level of such thresholds is usually more or less arbitrary. However, an examination of a set of decisions (e.g. PBAC decisions to list new medicines) provides an indication that the current threshold in Australia is somewhere in the vicinity of $70,000-$80,000 per QALY gained [11]. Moving from clinically relevant endpoints (such as reductions in BMI z-scores) to generic endpoints (such as QALYs gained) is difficult. There is a general problem that the tools for the measurement of health-related quality of life are imperfect and insensitive to gains in certain clinical areas [12]. Indeed, evidence suggests that the use of one quality of life valuation tool can significantly affect the score associated with a particular health state [13]. A further problem is that existing generic quality of life tools are designed for use in adults. While this may be a minor point in older adolescents, the concepts that make up general health-related quality of life (such as self care and anxiety) may be interpreted quite differently in a younger population. Work is being done in this area [14], but as yet no definitive solution to this problem has been identified.

A specific problem in converting short-term clinical endpoints to longer-term generic outcomes such as QALYs is that there is currently insufficient data on the natural trend in BMI following CBT (or any other behavioural therapy). We can make an assumption that an individual in the (for example) 95th percentile will remain in that percentile. However, this is a strong assumption as the individual, through CBT, may be more able to maintain a healthy weight throughout life than other individuals in that percentile. This uncertainty regarding what happens following the trial is a significant issue which requires one of three conclusions:

- A series of assumptions can be made regarding the future progression of weight and therefore disease in those receiving CBT;
- Longer-term data can be collected, following individuals to the point at which they begin to develop the main diseases associated with overweight and obesity; or.
- Economic evaluations can be undertaken based on short-term data, allowing decision-makers to decide whether the gain represents value for money over the long term.

Unfortunately, all three solutions have their own difficulties. Making assumptions about the future progression of weight and associated ill-health is beset by significant uncertainty as results from pertinent research are not available. Collecting long term data by following individuals over time would involve considerable cost and delay policies well beyond the time needed to implement policies. Using short-term data to undertake an economic evaluation would not produce results robust enough to inform decision-makers.

Implications for further evaluation of the CHOOSE HEALTH program

There is clearly still some additional work to be done to establish the effectiveness of CHOOSE HEALTH more rigorously. The work that has been done to date has involved a small number of participants, short term follow-up and has only trialled a one-to-one intervention. The short term analysis of the effects of CHOOSE HEALTH probably makes CBT for overweight and obesity appear less effective than it is. It is possible to identify those who respond positively to the program but we fail to capture the full effects of the program as long term outcomes in terms of maintained weight loss are not available. Levels of morbidity and mortality in adolescence are relatively small and it is unlikely that long term effects of weight loss can be captured using these outcomes.

From the perspective of an economic evaluation, a prospective randomised controlled trial including a realistic control group and longer term follow-up would enable the collection of longer term measures of effect such as the extent to which weight loss is maintained, quality of life and productivity (e.g. changes in capacity to work and study) which in turn would allow the calculation of QALY-type measures. However, this reduction in uncertainty (and hence need for arbitrary assumptions) remains until follow-up is completed for the period over which the risks of overweight and obesity are realised (which is generally when individuals are older adults).

Similarly, more work is necessary to estimate accurately the short and long term costs of different means of delivering the program. In the short run, as illustrated in the Table above, CBT for overweight or obesity in adolescents is likely to be expensive for a number of reasons. It is usually delivered as an individual intervention or in very small groups. There are large time demands on the health professional involved in delivering the program – we calculated that each participant received 16 hours of contact time plus preparation time.

Short term costs may be reduced by the use of group therapy (rather than individual therapy). If a similar outcome can be achieved, then the cost per child will fall in proportion to the group. This will then reduce all generated ICERs as the numerator will be reduced by a constant proportion. For example, if three children participate in all treatment and maintenance sessions, the cost per child falls to $383. There will also be savings if less qualified staff can be trained to deliver the program. So far, it has only been trialled in obesity interventions using highly qualified practitioners. Research has shown that, with appropriate training and supervision, non-psychologists such as diabetes educators, nutritionists and nurses can effectively deliver cognitive behavioural interventions. However, the potential cost-effectiveness benefits of doing so are dependent on two issues. Firstly, the cost of training these alternative staff must be

considered. Secondly, similar outcomes would have to be achieved relative to the original CHOOSE HEALTH program.

While it may be cheaper to offer the program in a group format, this may not deliver the same level of benefits; adolescents are very concerned that others will find out that they are attending a 'fat group' and it may be counterproductive to increase their anxiety about this, or put them at risk of being teased as a result of attending. It is also considered that one of the important components of the program is its emphasis on the parent-adolescent partnerships. This would be very difficult to create in a group setting, and in fact research suggests that for group work it is more effective to see adolescents and parents separately.

In the long term, the program might be expected to deliver some compensating cost outcomes. For example, fewer working days may be lost to obesity-related conditions, medical expenditure may be reduced and food expenditure may change (however the direction and scale of this change requires further investigation).

Conclusions

Overcoming the barriers to estimating accurately the long term costs and effects will not be easy. Even the best designed trial will deliver short term data, given that it would need to extend over decades to capture truly long term costs and outcomes, an unrealistic expectation. The most likely means we have at our disposal is to model the data. However, we are not able to do this currently, as the evidence which would enable us to make the links between i) intervention and behaviour change (i.e. reduced consumption, increased physical activity), ii) behaviour change and changes in weight and iii) changes in weight and long term morbidity and mortality does not exist! Thus, such modelling exercises would be complex and produce highly uncertain data.

Economic evaluation is a useful tool for providing clinical and policy relevant information about the extent to which alternative interventions, programs or services represents value for money. However, as has been shown here, it is of limited usefulness where the evidence is lacking in terms of long terms outcomes. If we cannot report the cost per life year saved or per QALY gained for CBT for adolescent obesity, then we are not able to judge its relative cost effectiveness compared to either other obesity interventions, other interventions targeting the health of adolescents or other interventions more generally.

Appendix 1

The CHOOSE HEALTH Program
Original 12 session version

Assessment
Intake Questionnaire: All parents interested in participating in the CHOOSE HEALTH program completed a phone intake survey to collect information about adolescent age, weight, height, previous weight loss attempts and the parent's motivations for participating in the program.

- Each intake questionnaire took approximately 15 minutes to complete. This would be required in a clinical or research setting.
- Cost: One page printing & phonecall

Assessment Interview: The Parent and Adolescent Overweight and Obesity Assessment Interview Schedule (PAOOIS) was developed specifically for the purpose of this research. This semi-structured interview schedule was used to collect information on the home environment, medical history, past and present weight, food intake and eating behaviour, social and cognitive factors, daily activity, exercise and sedentary behaviour of participants.

- Each assessment interview took approximately I hour to complete. This would be required in a clinical or research setting.
- Cost: Approx 12 page printing.

Monitoring: Adolescents monitored their eating and physical activity for seven days during each assessment period. Energy intake was recorded using a 7-day weighed food diary. Energy expenditure was measured both directly using accelerometers and indirectly via self-report. The adolescents wore a MTI Actigraph (Manufacturing Technologies, Inc. Model 7164) during the 7-day monitoring period. Adolescents reported their daily physical activity and sedentary time using the Self-Administered Physical Activity Checklist [SAPAC, 15]. In addition to the verbal instructions given at the completion of the initial interview, written instructions and sample diaries were provided to promote accuracy and compliance.

- Instructions regarding monitoring took approximately ½ hour at the end of each assessment interview.
- Scoring of the self-report physical activity data took approximately 30-minutes per participants per assessment occasion. Scoring of the accelerometer physical activity data took approximately 10-minutes per participants per assessment occasion.

This level of monitoring was necessary for research purposes, while some monitoring would be necessary for clinical purposes it would not need to be done this thoroughly.

Survey Assessments: To address key variables previously identified in the literature, a questionnaire package was completed by each adolescent and parent participant. The survey battery took approximately ninety-minutes to complete. It included measures of demographic and background information, psychosocial factors, psychopathology, family interactions, eating and exercise habits, motivation to change eating and exercise habits,

and assessments of treatment components. A summary of administered surveys is included in Table 3.

- Each parent and adolescent set of questionnaires batteries took approximately 45 minutes to score and interpret.

This level of psychosocial assessment was necessary for research purposes, while some psychosocial assessment would be necessary for clinical purposes it would not need to be done this thoroughly.

Table 3*: Summary of Adolescent Completed Measures*

	Adolescent	*Parent*
Background/Demographics		
Adolescent Health and Weight History Survey (AHWHS)	✓	✓
Psychosocial Functioning		
Rosenberg Self-esteem Scale (RSE)	✓	✓
Perceived Social Support Scale (PSS)	✓	
Family and Friend Influence on Health Behaviour Scale (FFIHB)	✓	✓
Psychopathology		
Depression Anxiety Stress Scale (DASS)	✓	✓
Adolescent Dieting Scale (ADS)	✓	
Eating Disorders Inventory – 2 (EDI-2)	✓	
Family Functioning		
Parent-Adolescent Communication -Adolescent Scale (PACS)	✓	✓
Family Problem Solving Communication Index – Adolescent Scale (FPSC)	✓	✓
Treatment Components		
Fat, Fruit and Vegetables Diet Questionnaire (FFVDQ)	✓	
Youth Behavioral Risk Survey - Diet Questions(YBRS-D)	✓	
Obesity Knowledge Test (OKT)	✓	✓
Automatic Thoughts Questionnaire (ATQ)	✓	
Social Skills Questionnaire (SSQ)	✓	✓
Social Competence Questionnaire (SCQ)	✓	✓
Parenting Scale (PS)		✓

Physical Assessments: Physical assessment sessions included assessment of resting metabolic rate, cardiovascular fitness, anthropometrics, body composition. .
Resting Metabolic Rate (RMR) is the amount of energy expended while at rest in a neutrally temperate environment, in the post-absorptive state. It was determined through indirect caloriometry that involves the measurement of gas exchange (the amount of oxygen consumed and carbon dioxide produced) on a MedGraphics (St. Paul, Minn., USA) metabolic measurement system. After an overnight fast, participants attended the laboratory and lay on a plinth for 10 minutes while a pneumotach mouthpiece was connected to sample expired air. Resting oxygen consumption and respiratory exchange ratio (RER) were used to calculate resting metabolic rate.

- *Cardiovascular fitness:* Cardiovascular fitness (CVF) was measured using a laboratory-based cycle ergometer (Lode N.V Groningen, Netherlands) test. This test has been shown by others to be an appropriate, valid and reliable measure of cardiovascular fitness when used with children and adolescents, including those who are overweight or obese [16, 17]. During the test, heart rate was monitored via Sports Tester (Polar, Finland) and oxygen consumption was measured using a MedGraphics metabolic measurement system (St. Paul, Minn, USA). The incremental test involved adjusting resistance every 150-seconds until peak oxygen uptake was achieved. Indices of CVF measured by this procedure include peak heart rate, peak/maximum oxygen uptake, peak power output and respiratory quotient. Cardiovascular fitness (CVF) was also determined for each participant through completion of a multi-stage shuttle test [18]. Most participants were familiar with the MSST through their school-based experiences. During the MSST, participants shuttled back and forth between two parallel lines set 20-metres apart. Participants were "paced" by a beep sounded by a compact disk player and aimed to complete each shuttle in time with the beep. Participants continued to run until they are unable to complete two consecutive shuttles in time with the beep or they voluntarily finished the MSST.
- *Anthropometics.* Standing height was measured with a calibrated stadiometer to the nearest 0.5 cm and body weight was measured to the nearest 10 grams on a calibrated set of digital scales. Both measurements were taken using standard procedures. Body circumference measurements were taken with a steel tape measure by a trained investigator to the nearest millimeter. Body circumference sites included hip, waist, upper arm and forearm. All measurements were taken from the right side of the body using standard procedures. Two separate body circumference measurements were made at each site and the mean score was recorded as the actual measurement.
- *Body composition.*Body composition was determined through whole body scanning using a Dual-energy X-ray absorptiometry (DEXA) apparatus (Lunar DPX densitometer (DPX). DEXA provides accurate and precise measurements of total body bone mineral content and total body fat mass [19] and has been determined to be a valid and reliable method of assessing whole and part body composition in children and adults [20]. Participants were positioned for each scan according to manufacturer's instructions. Scans were performed while participants wore light indoor clothing or a supplied hospital gown and no metal objects. Scan duration was 14-18 minutes, during which time participants lay motionless. The radiation exposure per scan was estimated to be less than 5mSv, which was lower than the daily background radiation level in the area and adhered to ethical guidelines for research.

A trained technician completed preparation of each scanned image, using appropriate anatomical landmarks to compartmentalise the body prior to application of the software and derivation of measures.

This level of physical assessment was necessary for research purposes, while some physical assessment would be necessary for clinical purposes it would not need to be done this thoroughly.

Treatment

Treatment was conducted on an individual basis. The intervention program consisted of 12 treatment sessions and 10 maintenance sessions (2 maintenance clinic sessions and & phone call sessions). Clinic sessions were scheduled for one hour and phone call sessions for 15 minutes. This includes time for the clinician to record treatment adherence, compliance and case notes.

Treatment sessions were conducted weekly for the first ten weeks. This was followed by a clinic session (Session 11), a phone call session, and a clinic session (Session 12) occurring fortnightly. Following the last treatment session phone call sessions were completed fortnightly. The first maintenance session was scheduled three months after the last treatment session and this was followed by bimonthly phone call session. The final maintenance session was conducted six months after the last treatment sessions.

Both parents and adolescents were required to attend the first six treatment sessions. Adolescent were then given the choice of attending the remaining sessions alone, or with the support of a parent. Generally, older adolescents chose to attend alone while the younger adolescents preferred their parent to be present. Parents were also provided with written session materials for sessions 7, 8 and 9. They were encouraged to work through these sessions independently and to contact the clinician to discuss any concerns or questions they had about the program material.

The CHOOSE HEALTH Program was developed for the purpose of this study. In addition to the eating and physical activity habit changes required for improved body composition and function, the program also focused on the physical, social, cognitive and emotional aspects of weight loss. The program aimed to increase the adolescent's knowledge and skills in each of these areas so that they were better able to make healthy eating and exercise choices and improve body composition and function. Parent self-directed sessions were designed to teach parents how to assist their adolescent to make healthy eating and exercise choices. They included information and strategies aimed at improving parent-adolescent communication, encouraging appropriate behaviour and managing inappropriate behaviour in their adolescent. Table 4 briefly outlines the topics covered in each session and is followed by more detailed information about each session.

- These procedures would be the same in a clinical or research setting.

Table 4: *CHOOSE HEALTH Intervention Sessions*

Intervention Session Number	Topic	Time

Treatment 1	Psychoeducation	1 hr
Treatment 2	Eating Behaviour	1 hr
Treatment 3	Physical Activity	1 hr
Treatment 4	Healthy Food Choices	1 hr
Treatment 5	Exercise	1 hr
Treatment 6	Behaviour Charts and Barriers	1 hr
Treatment 7	Recognising Thoughts and Emotions	1 hr
Treatment 8	Helpful Thoughts and Emotions	1 hr
Treatment 9	Assertive Communication	1 hr
Treatment 10	Problem Solving and Planning	1 hr
Treatment 11	Staying on Track	1 hr
Phone Call 1	Maintaining Change	15 m
Treatment 12	Maintenance and Closure	1 hr
Phone call 2	Maintaining Change	15 m
Phone Call 3	Maintaining Change	15 m
Phone Call 4	Maintaining Change	15 m
Phone Call 5	Maintaining Change	15 m
Phone Call 6	Maintaining Change	15 m
Maintenance 1	Maintenance	1 hr
Phone Call 7	Maintaining Change	15 m.
Phone Call 8	Maintaining Change	15 m
Maintenance 2	Maintenance	1 hr

Treatment session structure.

Each treatment session commenced with a review of the previous session and a discussion of homework, goal achievement and monitoring. The session material was then introduced with the opportunity for discussion, questions and practice of the strategies. Adolescents were encouraged to complete the exercises within the session. The adolescent was then assisted to set their own goals regarding use of the strategies prior to the next session. Each treatment session ended with a summary of the session material and setting of homework tasks. The clinician completed treatment adherence and compliance summaries, as well as case notes during or at the end of each session within the session time allocation.

- These procedures would be the same in a clinical or research setting.

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