RESEARCH

Evaluation of Lifetime Cost-effectiveness of Childhood Obesity Programme in Malaysia.

Lim Chin Choon 1* ; Asrul Akmal Shafie 2
authors' affiliations 1: Widad University College
2: Universiti Sains Malaysia

***Corresponding Author:** lcchoon@widad.edu.my

ABSTRACT

Background
[Childhood obesity leads to Non communicable diseases necessitating childhood obesity prevention programme.]

Aims
[To Assess the lifetime cost-effectiveness of childhood obesity health promotion program.]

Methods
[A Markov model was developed, comparing two health promotion programs (Sahabat Sihat and Be Best 2012) from Payor's perspectives with no program for obese and non-obese school children. Changes in weight and cardiovascular risk factors were modelled from a six-month active health promotion programs extrapolated to a lifetime study for childhood obesity. A probabilistic sensitivity analysis was conducted. Two groups of people were followed in the analysis: obese and non-obese school children. The cost-effectiveness was compared using incremental cost-effectiveness ratio (ICER).]

Results
[Be Best 2012 health promotion programs resulted in increased lifetime survival duration and quality of life. Sahabat Sihat is in extended dominance and Be Best 2012 is not cost effective at the Willingness to Pay ratio of RM 32000. One-way sensitivity analysis and probabilistic sensitivity analysis (PSA) showed that Be Best 2012 is more effective as a health promotion program compared to Sahabat Sihat.]

Conclusion
[This economic analysis suggests that health promotion program that is more effective or cost saving than Be Best 2012 is needed in the long run for childhood obesity.]

Figures and Tables: [11]

Key Words
[Cost Effectiveness, Childhood obesity, Markov model]

What this study adds:

1. What is known about this subject?
[Childhood obesity leads to cardiovascular diseases necessitating an early prevention strategy at childhood.]

2. What new information is offered in this study?
[There is a lack of evaluation based on Cost Effectiveness of Health Promotion Programs for childhood obesity in Malaysia.]

3. What are the implications for research, policy, or practice?
[Cost Effectiveness evaluation will allow proper funding for efficient program from payor's perspectives in Malaysia.]

Background

[Percentage of obese or overweight children in Malaysia increased drastically from 20.7% in 2002 to 26.4% in 2008 (1). Other studies showed that the prevalence of childhood obesity in United States increased at triple rate in 21st century compared to 1960s (2).
Based on current scenario, most obese adolescents (70%) will become obese adults (3) with increased risk of cardiovascular risk factors (hypertension, diabetes mellitus and hyperlipidemia) and diseases (stroke and myocardial infarction) (3, 4). Hence, it is not surprising that even in Malaysia, the

prevalence of cardiovascular diseases has increased nearly fourfold from 7.5% in 1965 to 27.8% in 1997 (5), whilst mortality rates because of CVD in Malaysia doubled from 24.1 in 1970 to 54.8 in 1996 per 100000 inhabitants (5).
Lifestyle interventions lead to improvements in clinical events like hypertension, diabetes, hypercholesterolemia and cardiovascular diseases (6). However, long term effects of health promotion programs for childhood obesity are rarely evaluated. Health promotion programs for childhood obesity are multi-factorial, which include promotion of a healthy lifestyle habits, dietary counselling, physical exercise training and behavioural change targets.]

Method

[Study question

Is Be Best (BB) more effective and efficient compared to Sahabat Sihat (SS) to prevent childhood obesity?

Relevance of these studies for health policy or practice decisions making.

Based on studies done for economic evaluation for childhood obesity, most of the intervention was not effective in preventing childhood obesity though some studies showed slight improvement with intervention particularly in physical activities. Furthermore, it is essential to note that most studies evaluated only short term intermediate outcome. Longer time horizon is needed to capture preventable health outcomes associated with obesity. This is reflected where a more positive outcomes are observed in studies that cover a horizon of more than two years like APPLE studies in New Zealand (7). Even though obesity prevention program is vital, there is scarce evidence of optimum mix of program structure that could provide the maximum effectiveness at the lowest cost. Most available evidence only analyze short term outcome which would underestimate the whole spectrum of a prevention program outcome.

Therefore, intermediate and long term economic evaluation of health promotion program with Markov model, based on incremental cost effectiveness ratio (ICER) for the respective program followed by deterministic and stochastic analysis was conducted.

Study Designs

Intermediate economic evaluation was conducted based on prospective data collected for both cost and effectiveness from SS and BB.

Study Population and Sampling Frame

All participants in the program were included in the intermediate economic evaluation. For lifetime economic evaluation, 10000 hypothetical cohort projected from the respective intermediate study with hypothetical age from 30-75 years old and a BMI more than 30 was used as input in the Markov model.

Markov model description

A Markov decision model (8) was developed to evaluate the lifetime effect of a six month health promotion program compared with no program for obese and non-obese participants.Seven states were modeled: “obese or non-obese children”, “obese or non-obese adults free of complications”, “hypertension” if patients developed hypertension (systolic blood pressure above 140 mmHg and diastolic blood pressure above 90 mmHg) (9), “diabetes” if fasting glucose above 7.0 mmol/l or 2-hour glucose above 11.1 mmol/l (10), “hypercholesterolemia” if total serum cholesterol ≥ 5.18 mmol/l (11), “cardiovascular disease”, if patient developed stroke or myocardial disease and “death” whereby patients die.Obese and non-obese subjects that participate in the respective health promotion programs (SS and BB) entered into the model in the ‘obese’ health state at age 30. The cycle length was one year. At the end of each one year period, cohort can move from one disease state to another or maintain the status quo. Transition probabilities were based on cardiovascular events depending on age, obesity status and cycle number. It is assumed that obesity status in childhood is maintain up to 30 years old in adulthood. Lifetime, 45 years of annual cycles (30-75 years old) for obese male was used in the Markov model to estimate the lifespan, lifetime costs and health effects of childhood obesity health promotion programs. The lifetime of the model is approximate to the average life expectancy of male in Malaysia (71.9 years old) (12).

In the cost-effectiveness model, all patients that developed hypertension, diabetes and hypercholesterolemia were assumed to be diagnosed and treated. Patients also remain in cardiovascular risk factors states once they entered before progressing to cardiovascular disease or die. Markov model develop also assumed that cardiovascular risk factors (diabetes, hypertension and hypercholesterolemia) and cardiovascular diseases are not interrelated and no additive effect on lifetime health and costs. However, this assumption will underestimate the burden of co-morbidities associated with obesity.

Data Analysis

Data was analyzed based on Incremental Cost Effectiveness Ratio (ICER).

$$ICER_t = \frac{\text{cost program } A_t - \text{cost program } B_t}{effectivenessA_t - effectivenessB_t}$$

Whereby
t = lifetime
effectiveness = QALY

A Markov trace of Markov cohort was obtained. Deterministic study was based on ICER value, whilst, stochastic study was based on one-way analysis, threshold analysis and Probabilistic Sensitivity Analysis (PSA). PSA was presented in a scatter plane and cost effectiveness acceptability curve (CEAC) (13).

Characteristic of the base case population

Ninety eight and 112 obese and non-obese school children between 7 - 19 years old within the vicinity of Penang (SS) and Tobiah, Kedah (BB) were chosen for this study. Students were obese and non-obese respectively without any severe disability/illness nor illiterate in either Malay and English language.

Study perspective

Payor's perspectives were chosen because both health promotion programs (SS and BB) for childhood obesity was funded by grant from "My Sihat"

Relation to cost

Cost of the programs was funded by "My Sihat" for intermediate study. However, cost for the final study was based on the published study on cost to treat cardiovascular risk factors and diseases. Data from Malaysian study was given top priority compared to other available data worldwide.

Parameter estimates and data sources

Data for cardiovascular diseases was based on literature review, census data and government survey in Malaysia

Summary of Parameters and Values Used in the Base-Case Markov Model

Markov model was developed from various secondary sources. The relationship between obesity and annual risk of hypertension, diabetes, and hypercholesterolemia was adjusted based on study conducted by National Health and Morbidity Survey (14). The annual risk of developing cardiovascular diseases were based on risk equations created for the Framingham cohort study (15). Mortality rates of both obese and non-obese subjects in normal health state and those with hypercholesterolemia were assumed to be equivalent to natural death rate in the general population.

Age specific mortality data were obtained from Death statistic data in Malaysia (16). The yearly probability for diabetes, hypertension, coronary heart disease and stroke were obtained from National Health and Morbidity Survey 2012 (14), Framingham study (15) and the actual number of death in Malaysia (16).

EQ-5D Utility score represented the strength of patients' preferences for their own health with a scale ranging from 0.0 (death) to 1.0 (perfect health). EQ-5D were chosen as the outcomes measures of benefit, as EQ-5D was based on patients' perception of their disease and EQ-5D values for cardiovascular risk factors and related diseases were available from published literature. Meta analysis of EQ-5D studies for clinical events for childhood obesity were conducted to obtain the HRQoL utilities for obesity and clinical events associated with the complications of obesity.

For obese and non-obese children, health promotion costs consisted of activity conducted by SS and BB. Cost of obesity medications are not included in standard treatment of obesity even if they are available (17) as they are not part of standard care. Data for cost of treatment for cardiovascular risk factors and diseases were taken from adapted published study in Malaysia (18, 19) and worldwide (20, 21) and adjusted to 2013 Malaysia prices using the 3% inflated rate. This included only the direct cost of the disease.

Based on current Markov models, transition probabilities to the cycle time of the model were based on actuarial method with a half-cycle correction.

Assumptions and methods of extrapolation of intermediate study to the long term study in Markov model were described and justified.

Table 1 is the source of data input for Markov model.

Discount rate

Discount rate for costs and the outcome were based on 3% respectively.

Currency, price data and conversion

Unit cost was based on Malaysia Ringgit (MYR) in the current Malaysian study and adjusted up to the base year 2013. Cost that was not dominated in MYR was converted to MYR based on purchasing power parity (PPP) published by World Bank.

Choice of model

Cost-utility analysis (CUA) was selected and Markov model was used to model the lifetime effectiveness of health promotion program for obese children as it would be tedious and time consuming to conduct a conventional cohort study for health promotion for childhood obesity.

Analytical methods

Markov model was validated based on systematic review of available model, expert opinion, internal verification and both internal and external validation.

Model validation

Validation is the process of checking the accuracy of results when extrapolating intermediate study to long term study (22).Weinstein categorized validation into internal validation, between model validation and external validation (23).

Internal validation

In order to verify childhood obesity model constructed for internal consistency, different sensitivity analyses in terms of model parameters and modelling assumptions were carried out. Verification ensure the accuracy of mathematical calculations in producing the expected output (23). One of the methods for verifications is Debugging. Debugging was conducted to verified the accuracy of data input for included parameters (23). In debugging, consistency of survival will be tested, whereby, transition probability for death state will be check whether it sum to "1" if transition probabilities for all other health state were to be set as "0".

Verification of the model against null or extreme input value for sensitivity analysis was conducted as well to check whether they produced the expected output. This includes examination of the program codes for syntactical errors and tests of replication using equivalent input values (23). Verifying also involved verifying the individual equations, coding and validating against the data sources (23) by the main researcher and an independent expert.

Between model validation

In dependent validation, same source of data input was used to estimate and validate the model's equation (24).

Model are valid if they are able to reproduced results from the data sources used to create it (25). The prevalence of obesity for 30 years old cohort in Malaysia predicted from the present model was compared to survey data conducted by National Health and Morbidity Survey 2011 in Malaysia (26). Dependent validation for this study was confirmed by comparing the lifespan of obese individuals predicted from the model constructed with estimated lifespan of obese individuals derived from the cohort of Framingham Study as Framingham study was used to construct the current model.

External Validation

In independent validation, the model is compared to independent study that was not used to build the model (27, 28) and the calculated outcome is compare to the real world one to established validity and credibility of the model (25).

Between-model consistency was assessed by simulating some criteria of present model with those of similar models published and comparing the results from both studies (23).

Lifespan for obese subjects was compared with other studies worldwide.

Face validity

Face validity of the model addresses how well the model were able to represents the diseases of interest, settings, populations, interventions and relevant outcome.

Expert opinion can be utilized to ensure face validity of the developed model and whether they were true in real-world practices (29).

In expert opinion, selection of expert, expert credibility and diverse expertise between experts in the field of interest is essential to avoid bias opinion in the intervention (30).

One of the methods for expert opinion utilized group meetings, whereby five to eight experts is consulted. If fewer experts were present, a single expert will dominate the meeting and too many experts will results in disability of participants to express their opinions optimally (30).

Expert panel for childhood obesity involved general physicians and public health experts to provide the necessary bio-clinical knowledge and one health technology assessor to give guidance on the parameters and structure of the model. Two sessions of meetings of one hour each was conducted.

First meeting

The first meeting started with the development of a framework for childhood obesity. This was followed by the aim of the research and the objective of the study. Next, questions on decision problems, perspectives and assumptions were discussed.

Process

The questions were open-ended to allow the expert to give their opinion based on their expertises; whereby five minutes were devoted to each question. Adequate time was given to other questions or opinions subject to the need and availability of time.

Output

A list of assumptions about the natural course of childhood obesity, measurement outcomes and time horizon resulted from the discussions with the experts.

Interim

A preliminary structure of the model was developed from the assumptions generated. Once a proper structure was developed based on the assumptions, a systematic search of the published literature was performed to assess whether a similar model structure already exists. If available, a good model was incorporated into the present model.

Second meeting

Input

The second meetings started with a brief overview of the modelling process and discussions were based on the general types of economic models available for this study from systematic review conducted. Finally, the suggested model was presented to the experts.

Process

Based on the guiding questions from this meeting, the systematic review's model was compared to the developed model to see which model best represent the assumptions made in the first meeting. It allowed the experts to refine the model structure of both systematic and developed model.

Output

At the end of the second meeting, the experts made a choice between the systematic or developed model and determined how the model would look in its final form. The product of the model was a figure or other schematic representation.

Methods conducted for dealing with skewness, missing or censored data.

Missing or censored data from the intermediate study for both obese and non-obese children was excluded from intermediate and final studies.

Extrapolation methods

Primary data from intermediate study was extrapolated to the long term study, while, secondary data for the model was based on literature review of published article.

Methods for handling population heterogeneity

Populations were assumed to be uniform as intermediate study utilized primary data from healthy obese and non-obese school children at the initial of the study.

Cost-effectiveness analysis

In this study, obese and non-obese adults from the cohort of school children were followed. Subjects in the obese cohort have a BMI more than 30 kg/m^2. Differences in mean costs, life-years (LY) and quality adjusted life-years (QALY) were compared between SS and BB intervention respectively with no program. The cost-effectiveness of interventions was evaluated using incremental cost-effectiveness ratio (ICER). Numerator for ICER is lifetime cost of obesity and denominator for ICER is survival or Quality Adjusted Life Years (QALY). Incremental costs were reported in Malaysia Ringit (MYR). The analysis was discounted at 3 % rate for cost and effect respectively.

Uncertainty

In order to assess the impact of statistical uncertainty around key model inputs, a series of one-way sensitivity analyses and probabilistic sensitivity analysis (PSA) was conducted. Scenario analyses were used to assess the impact of additional assumptions not primarily related to statistical uncertainty.
In one-way sensitivity analysis, parameters for transition probabilities, utility and costs of childhood obesity was analysed using a range of extreme valuation from their base case.

Sensitivity analysis

A probabilistic sensitivity analysis (13) (PSA), was used to study the effect of uncertainty in data inputs for transition probabilities, cost and utility values.
In order to propagate uncertainty, distributions were assigned to all parameters that were estimated with uncertainty. The distributional forms of the model parameters are: beta distribution for both transition probability and utility scores, lognormal distribution for relative risk.and gamma distributions for costs of interventions. Values were drawn at random from specified distributions using a random number generator for the chosen parameter.
Second order Monte Carlo simulation was used to propagate these distributions through the model in Probabilistic Sensitivity Analysis (PSA) by recalculating the results over a large number of iterations. The results of running PSA randomly from the parameter distributions were then presented on the cost-effectiveness plane (13) and cost-effectiveness acceptability curve (CEAC) (31).

Technical implementation

Markov model, Markov trace and Monte Carlo simulation were analyzed using Excel 2007 (Microsoft Excel, Microsoft Corporation, USA). Probabilistic Sensitivity Analyses were based on one thousand sets of randomly drawn input parameters.]

Results

[Health Promotion Program (SS and BB)

Basically, there were 0% and 28% reduction in the number of obese cohort after six months of health promotion program for SS and BB cohort respectively compared to baseline.

Internal validation

Results from debugging showed consistency of survival. Result of sensitivity analysis for null and extreme input value for lifespan of obese individuals was described as in Table 5.
Results of Table 2 showed that the lifespan of obese children was within plausible range of 53.7 to 68.6 years old with extreme input of parameters.

< Insert Table 2 >

Internal validation was documented systematically in this study and the results were consistent for individual equations, coding and data sources as elicited by both the main researcher and an independent expert.

Between Model validation

Based on table 3, the prevalence of obesity in Malaysia predicted from the present model was 7.7%, which was comparable to obesity prevalence of 7.4% obtained by National Health and Morbidity Survey 2011 (NHMS) in Malaysia (26).

Absolute lifespan for obese male children was estimated to be 68.2 years old, which is 3.8 years shorter than non-obese individuals (average lifespan of 72 years old) in Malaysia in 2011 (12). Obese male in Framingham study's cohort also have a shorter lifespan of 5.8 years old (32) compared to non-obese male. This showed that the childhood obesity model developed was able to predict the shorter lifespan for obese individuals as in Framingham's cohort with slight different in lifespan due to input of data for cardiovascular risk factors in the current obesity model with local Malaysian data (26).

External validation

Based on table 4, independent studies conducted by Fontainne and Reuser in US confirmed that the year of Life Losts (YLLs) due to obesity was 4 and 3 years respectively for adult white male (33). This was similar with the shorter lifespan of 3.8 years predicted for the obese male cohort from the current childhood obesity model.

Life expectancy of obese cohort for the present model was 68.2 years old, compared to life expectancy of 71.5 for obese cohort obtained by 2000 Medical Expenditure Panel Survey (2000 MEPS) conducted in US (34). The lower life expectancy was due to lower average life expectancy of 72 years old for Malaysian (12) compared to average life expectancy of 74 years old in US (34).

Face validity

Expert opinion conducted had concluded that the final childhood obesity model was as Figure 1.

Base case analysis

In the base case analysis, the model indicated that SS and BB would lead to a gain of 0 and 0.01 QALYs per patient at an additional cost of MYR 503 and MYR 411 respectively.

SS is in extended dominance and BB is not cost-effective at the WTP ratio of RM32000.

Uncertainty Analysis (Deterministic Study)

One Way Analysis

In one-way sensitivity analysis, variation of transition probabilities, cost, utility parameters and relative risk were carried out. As no confidence intervals were available for most of these parameters, extreme value was used in one-way analysis. Results of one-way analysis for incremental cost-effectiveness ratio (ICER) for BB and SS were presented as a tornado diagram.

Tornado diagram were summarized as in Figure 2. Change in yearly transition probability of childhood obesity to obesity for BB's cohort to 1 had the biggest impact on ICER for BB cohort, whilst change in EQ-5D health utilities for hypercholesterolemia to 1 had the second-biggest influence overall on ICER value for BB and change in other parameters had only marginal impact on ICER value for BB. Most of the performed analyses resulted in an ICER above the WTP threshold of MYR 32000/QALY.

Threshold Analysis

As in Figure 3, cost-effectiveness of BB's will remain below the Willingness-to-Pay (WTP) value of MYR 32000 only if the cost of BB Health Promotion Program is below MYR 300. The incremental differences in costs and effects between both SS and BB intervention and no program respectively from PSA were presented in Table 5.

Probabilistic Sensitivity Analysis (PSA)

SS health promotion program resulted in marginal or no increase in survival and quality of life compared to no program. While, BB resulted in an increase in quality of life, which is equivalent to a difference of 0.01 QALY (compared to no program) per person gained over the lifetime study. Based on PSA result, BB dominated SS in the Cost-effectiveness plane.

Cost Effectiveness Scatter-plane

To reflect the uncertainty analysis in Figure 4, a scatter plot of the mean differences in costs and QALY gained between both SS and BB compared to no program, derived from the Monte Carlo simulation were presented.

The concentration of BB in Quadrant I indicate that BB is 50% more effective than no program at RM 32,000 willingness to pay ratio.

Cost Effectiveness Acceptability Curve

The cost-effectiveness acceptability curves were shown in Fig. 5. BB effectiveness is nearly equal to no program at value of Ceiling ratio of RM32000.

Discussion

[It was assumed that students with (BMI > 95th percentile) for age group is obese. As the children become adults, BMI was defined as follow: obese (BMI > 30 kg/m2) and non-obese (BMI < 30 kg/m2). In the current study, students were assumed to have a status-quo of obesity until 30 years old if at the end of health promotion program they were obese.

Based on health promotion program conducted for obese and non-obese children a Markov model was developed to study the long term benefit related to weight loss. The benefit of weight loss was described as a reduction in the cardiovascular risk factors and diseases, increased life expectancy and quality of life as well as a reduction in costs of treatment due to sequel of obesity.

BB shows a positive effect after six months of health promotion programs for cohort of school children compared to SS which does not resulted in increased survival and improved quality of life compared with no program.

One important issue in the cost-effectiveness analysis is that the maximum willingness to pay for one unit of increased quality of life is not known. It has been suggested that incremental costs of less than MYR 32000 per QALY are cost-effective as the threshold represent 1 time Malaysia's GDP in 2012.

The results of the current study were compared with published economic evaluation literature for overweight and obese children worldwide.

For Instance, studies like Planet Health performed an economic analysis on the effect of health intervention on obese secondary school children. Compared with standard care intervention, lifestyle intervention in Planet Health resulted in an ICER of approximately USD 4305 (35).

Another modelling study performed by ACE-obesity project in Australia, estimated the DALY saved with various lifestyle intervention compared with no program (36). The effectiveness was found to be varied between lifestyle interventions (36).

In the US, a mathematical model was used by Wang et al., 2010 to study the effect of a 1% reduction in both overweight and obesity status at childhood on obesity status, burden of diseases and mortality in adult. This study showed that lifetime medical care costs after 40 years old (for current obese children) would reduce by $586 million and lifetime QALYs would improved by 47,138 with a projection of a 1% reduction in childhood obesity status (37).

Studies conducted based on UK National Health Services perspectives showed that childhood obesity intervention was cost-effective with cost per life year gain of £13589 (4).

These studies showed that the success of health promotion programs for childhood obesity in the long run varied. Therefore, a better understanding of evident based health promotion program for childhood obesity is essential to design a more effective and efficient health promotion programs in the future.

This cost-effectiveness study illustrates from a Malaysian perspective the lifetime impact of health promotion programs for childhood obesity. The obtained results necessitate a more effective or more cost saving compared to BB to justify the funds allocated for health promotion program for BB.]

Conclusion

[In summary, health promotion program conducted by BB is not cost-effective in the long-term for childhood obesity. Our economic analysis suggests that more effectively conducted or more cost saving health promotion program than BB is required for the long-term prevention of childhood obesity in Malaysia.]

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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[MySihat]

ETHICS COMMITTEE APPROVAL

[MySihat ethics committe confirmed that ethics approval is not needed in this study]

Figures and Tables

[Figure 1 Childhood Obesity model developed from expert opinion.

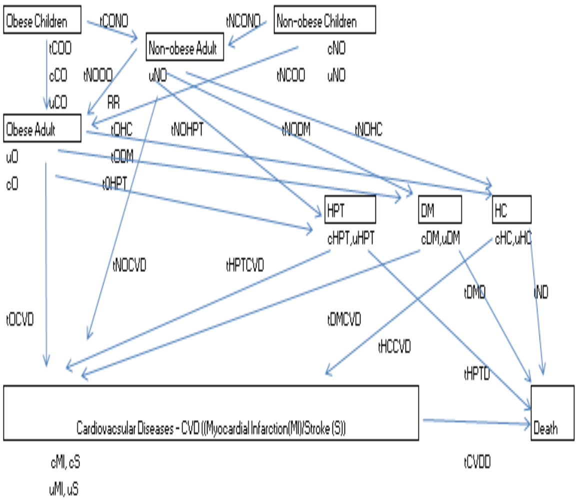

Figure 2 Cost Effectiveness Scatter Plane for Health Promotion Program for Childhood Obesity

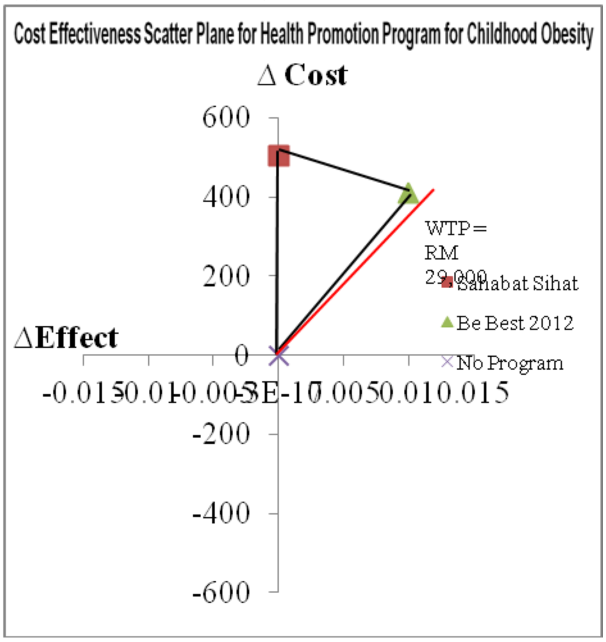

Figure 3 Tornado Diagram for Percentage (%) change in ICER with extreme value for input parameters for BB

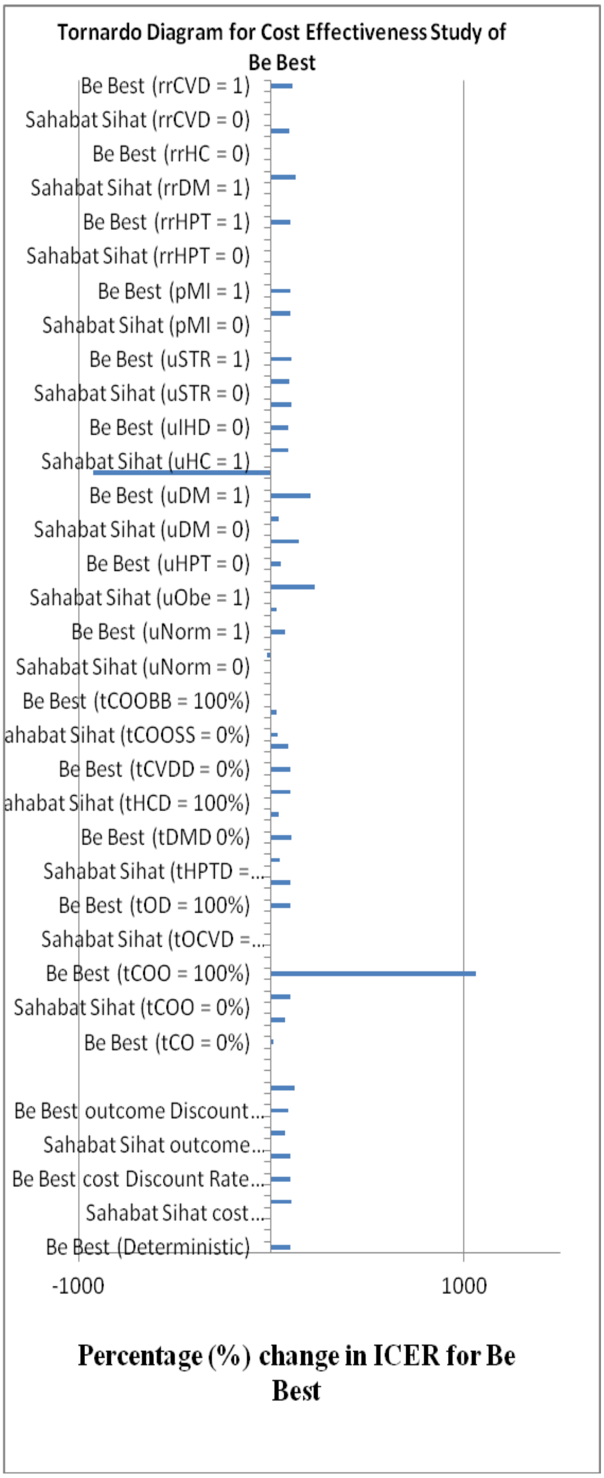

Figure 4 Threshold Analysis for cost of BB program.

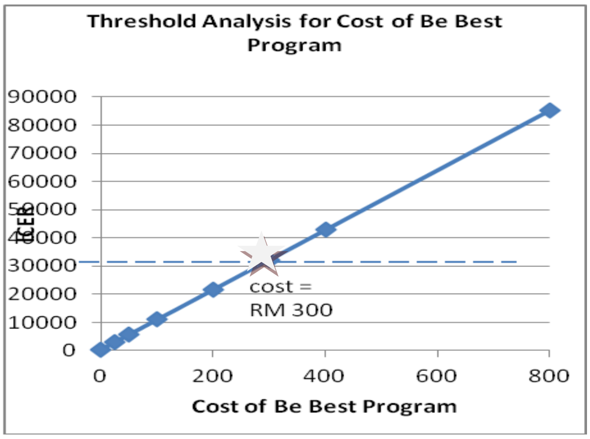

Figure 5 Cost Effectiveness Scatter Plane for Health Promotion Program for Childhood Obesity

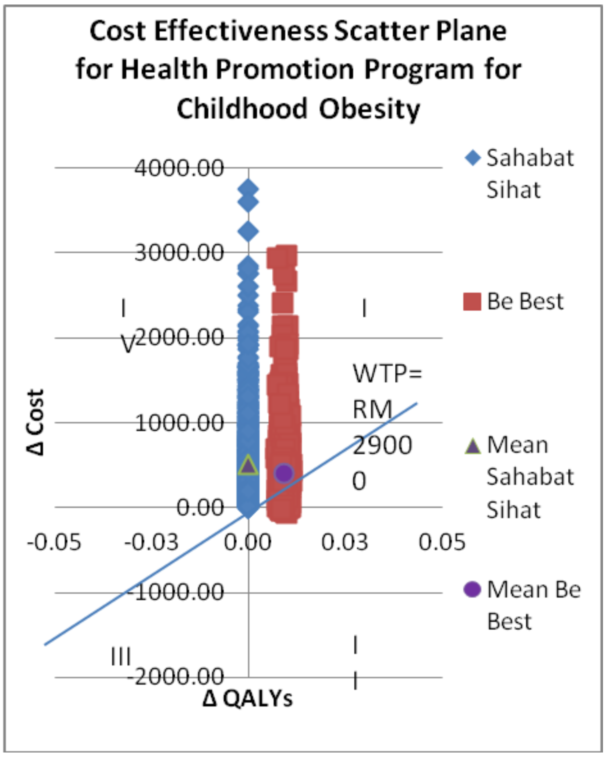

Figure 6 Cost Effectiveness Acceptability Curve for Childhood Obesity model

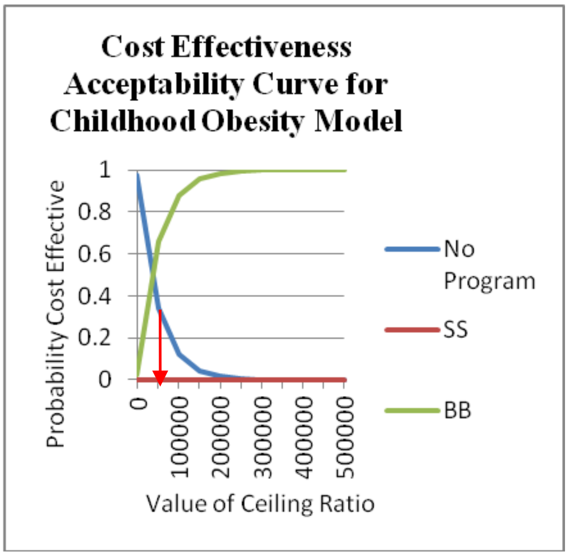

Table 1 Source of data input for Markov model

Items	Data Source	Descriptions
Transition Probability for childhood obesity	Health Promotion Program	Data source from NGOs (SS and BB)
Transition Probability for obesity in adult, cardiovascular risk factors and cardiovascular diseases.	National Health and Morbidity Survey in Malaysia (NHMS 2011), Framingham study, census and death statistics of	Data source from study with large sample size or local data

	Malaysia	
Cost data source	Published study in Malaysia and worldwide	Study with large sample size
HRQoL (EQ-5D)	Meta Analysis of available literature	Combined mean and standard error were included
Relative Risk	Published literature worldwide	Published Meta Analysis study

*NGOs – Non-Governmental Organizations, SS – Sahabat Sihat, BB – Be Best, HRQoL – Health Related Quality of Life

Table 2 Lifespan of obese individuals with extreme value input for parameters.

Input for Parameters	Lifespan of obese children (years)
Transition probability of obesity to cardiovascular diseses = 0	68.2
Transition probability of obesity to cardiovascular diseses = 1	67.0
Transition probability from hypertension to death = 0	68.3
Transition probability from hypertension to death = 1	53.7
Transition probability from diabetes mellitus to death = 0	68.6
Transition probability from diabetes mellitus to death = 1	57.9
Transition probability from cardiovascular disease to death = 0	68.4
Transition probability from cardiovascular disease to death = 1	62.1

Table 3 Results of dependent validation conducted for childhood obesity model.

Parameters	Obesity Model for Malaysian children	Other studies	Studies for comparisons
Prevalance of obesity	7.7 %	7.4 %	National Health and Morbidity Survey 2011 (NHMS) in Malaysia (Suzana et al., 2012)
Years of Life Losts (YLLs) due to obesity	3.8 years	5.8 years	Framingham study (Peteers et al., 2003)

Table 4 Results of independent validation conducted for childhood obesity model.

Parameters	Obesity Model for Malaysian children	Other studies	Studies for comparisons
Years of Life Losts (YLLs) due to obesity	3.8 years	4 years	Fontainne (Finkelstein et al., 2010).
Years of Life Losts (YLLs) due to obesity	3.8 years	3 years	Reuser (Finkelstein et al., 2010).
Life Expectancy	70.2 years old	71.5 years old	2000 Medical Expenditure Panel Survey conducted in US (Muennig et al., 2006).

Table 5 Incremental differeneces in costs and effects between SS and BB.

	ΔCost	ΔQALYs	ICER
SS	MYR 503	0.00	MYR 132,538,682.63
BB	MYR 411	0.01	MYR 41,437.84

*SS – Sahabat Sihat, BB – Be Best , QALY – Quality Adjusted Life Years, ICER – Incremental Cost Effectiveness Ratio]

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