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Cost-Effectiveness of a Weight Loss Intervention: An Adaptation of the Look AHEAD Lifestyle Intervention in the US Military

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Contents

Abstract

Objective: To assess whether a counselor-initiated adaptation (CI) of the Look AHEAD Intensive Lifestyle Intervention (ILI) in a military setting was cost-effective relative to a self-paced adaptation (SP).

Methods: We performed cost-effectiveness analysis from a payer perspective alongside a 2014-2017 randomized behavioral weight loss trial among 248 active-duty military personnel stationed at a US Air Force Base in Texas. We calculated incremental cost-effectiveness ratios (ICERs) for weight loss, reductions in waist circumference, and quality-adjusted life years (QALYs).

Results: After 12 months, the CI adaptation cost more per participant compared to the SP adaptation ($1,081 vs. $120), but achieved greater weight loss (1.86 vs. 0.06kg), reductions in waist circumference (1.85 vs. 0.48 cm), and more QALYs (0.871 vs. 0.856). The ICER for CI relative to the SP adaptation was $61,268 per additional QALY. At willingness-to-pay thresholds of $50,000 and $100,000 per QALY the CI adaptation was 45 and 49% likely to be cost-effective.

Conclusions: The CI delivery of the Look AHEAD ILI may offer a cost-effective approach to tackle excess weight in the US military.

Introduction

Evidence of the effectiveness of a health promotion intervention alone is often insufficient for informed decision making. Public health resources are limited and decision makers are required to set priorities when allocating scarce resources. Evidence derived from economic evaluations such as cost-effectiveness analysis of health promotion interventions can assist decision makers in setting priorities within their monetary budgets. In addition, evidence-based health promotion interventions, including weight loss and weight management interventions, should be tailored to accommodate the target population's specific context and needs.(1, 2) It is valuable to examine the cost-effectiveness of a tailored intervention because differences in the context and needs from one population to another and unique changes made to an intervention may affect the costs as well as the effectiveness.(3)

The US military represents one important population that could benefit from tailored weight loss and weight management interventions. In 2016, the US Department of Defense (DoD) employed over 3.5 million people, including over 1.2 million active-duty personnel in its services branches: Army (471,271), Navy (320,101), Air Force (313,723), and Marine Corps (183,501).(4) The alarming increase in overweight and obesity in the US and around the world has been the subject of considerable attention.(5) Despite the considerable emphasis on physical fitness, the US military has not been exempt from these trends.(6) Body mass index (BMI), an individual's weight in kilograms divided by the squared height in meters can be used to categorize individuals into weight categories. Generally, for adults aged 20 years and older, a BMI between 25.0 and 29.9 kg/m^2 places an individual in the overweight category and a BMI of 30 kg/m^2 and greater in the obese category.(7) Based on these categories, approximately 51.0%

of active-duty service members are overweight and 14.7% are obese compared to 31.6% of the general US adult population that is estimated to have overweight and 39.6% that is estimated to be obese.(6, 8) Excess weight and inadequate fitness are associated with higher risk of incident lower extremity musculoskeletal injury disorders(9) and absenteeism rates among overweight and obese active-duty personnel and substantial costs for the DoD, including increased medical care and the cost of recruiting and training replacements for individuals discharged due to fitness test failure.(10) Dall et al.(10) estimated that 658,000 full time equivalent work days are being lost each year from absenteeism associated with active-duty personnel who are overweight or obese at an annual cost of $103 million for the DoD and that the costs for the medical care of active-duty personnel and their dependents, and military retirees and their dependents associated with excess weight and obesity exceeds $1 billion annually. The Accession Medical Standards Analysis and Research Activity estimates that the cost of recruitment, screening, and training is $75,000 per enlistee, making each fitness-related discharge expensive for the DoD.(11) Members of the armed forces must meet strict fitness standards (e.g. abdominal circumference). Failure to meet these standards can result in military discharge which has nontrivial consequences, including loss of wages, medical benefits and years of service towards pension eligibility.(12)

The Fit Blue study, a randomized, controlled, behavioral, weight loss trial for active-duty personnel, translated the Look AHEAD Intensive Lifestyle Intervention (ILI)(13) into the military setting, specifically the Lackland Air Force Base in San Antonio, Texas. The participants were predominantly (94%) Air Force personnel. Design details for the Fit Blue intervention have been described previously.(14, 15) In short, the Fit Blue study compared two adapted versions of the Look AHEAD intervention: a counselor-initiated (CI) and a self-paced

(SP) condition. The two groups differed in the degree of intervention intensity and the amount of self-initiation required.

Given the prevalence and adverse consequences of excess weight in the United States military, examining the potential value (cost versus outcomes) of weight loss and weight management interventions in this setting is important. The purpose of this study was to assess the cost-effectiveness of the CI relative to the SP adaptation of the intervention.

Methods

Study Participants and Intervention

The Fit Blue intervention was delivered over the phone and e-mail to make it more accessible to military personnel who are frequently on brief assignments in different locations, known as Temporary Duty. Participants in the Fit Blue study were active duty military personnel stationed at the Lackland Air Force Base. To be eligible for the study, participants had to be over 18 years of age, have a body mass index (BMI) of 25.0 kg/m^2 or greater, have computer and email access, and have at least one year of service left at the Lackland Air Force Base to minimize the likelihood for loss to follow-up at 12 months. The time-horizon for the intervention was one year with data collected at baseline, 4 and 12 months. The primary outcome variable was weight loss at 12 months. Recruitment took place from January 2014 to March 2016, and data were collected until March 2017. Participants were randomized to CI (n=124) or SP (n=124) intervention conditions. Trained lay interventionists were either military retirees or staff who had significant knowledge of military culture. All interventionists had bachelor's or master's degrees in diverse areas of study. During one-on-one phone sessions, interventionists provided strategies to help participants with weight loss. Self-monitoring sessions consisted of interventionist feedback via email on participants' food and physical activity using the Lose It!™ Website and app, and weight uploaded by participants to a secure website through Body Trace™ electronic scales. Participants in both conditions could receive up to 28 phone sessions and 28 self-monitoring feedback emails. However, while CI participants received phone calls (phone sessions) and e-mails (self-monitoring feedback) regularly by interventionists, SP participants were required to self-initiate requests for those interactions. In addition, only CI participants were able to receive meal replacements and participate in four four-week-long challenges designed to increase motivation. Participants who successfully completed a challenge received a small prize. CI participants also had access to a toolbox which included additional resources such as exercise videos and cook books. These items could be borrowed but had to be returned prior to the end of the study.

Model Structure

We developed a decision-tree model using TreeAge Pro 2018 (TreeAge Software Inc, Williamstown, MA) to estimate the costs and outcomes associated with the Fit Blue intervention after 12 months. The model included the possible pathways for both intervention conditions and whether there was a significant weight loss (≥5% of initial body weight lost) or not (<5% of initial body weight lost). Possible pathways also included whether CI participants had received at least 75% of possible phone sessions and self-monitoring feedback (28 of each were possible, so 42 out of 56 possible interactions) or not, whether SP participants had any interactions or not, and whether participants in both conditions returned for the 12-month data collection or not.

Model Input Data

Model input parameters, including probabilities, were derived from the Fit Blue trial data. Total costs and per person costs were calculated included the following for both interventions: intervention materials, shipping costs, telephone and self-monitoring sessions, and incentives for participation in data collection (Table 1). CI additionally included costs of challenge prizes and meal replacements. Costs for telephone and self-monitoring sessions were calculated based on the amount of time that interventionists spent providing telephone sessions and self-monitoring feedback multiplied by the average hourly rate, including fringe benefits, paid to study interventionists. Costs for challenge prizes depended on the number of challenges participants had participated in. The cost of meal replacements was calculated based on the number of meal replacements consumed multiplied by the average cost per meal replacement. We estimated the intervention costs in both conditions from a payer perspective. Since all intervention activities happened outside of participant work time, participant time costs were not considered. Only costs related to administering the Fit Blue intervention were included. Costs for staff training, program development, and research costs were excluded. Costs are measured and reported in US dollars at 2016 price and wage levels.

Our analysis focused on three different outcome measures at 12 months: weight loss (in kilograms), reduction in waist circumference (in centimeters), and quality-adjusted life years (QALYs). QALYs were calculated for one year and were estimated based on participant responses to the Health Utility Index Mark 2 (HUI2®) questionnaire. For missing values at 12 months, we carried forward the baseline observation which is considered a conservative estimate for completing missing values.(16) We conducted univariate comparisons of mean outcome measures using Student's t-tests and chi-square for comparing proportions.

Cost-Effectiveness Analysis

We calculated three incremental cost-effectiveness ratios (ICERs), corresponding to each outcome: incremental cost per kilogram of weight loss, incremental cost per centimeter of waist circumference reduction, and incremental cost per QALY. The ICER is defined as the difference in costs divided by the difference in the effects of the two intervention adaptations.(17)

To test the sensitivity of our results to model assumptions, we conducted a series of sensitivity analyses. For the reason that another organization may want to implement the intervention with existing (more or less expensive) staff which would impact overall intervention costs, we conducted a one-way sensitivity analysis of hourly wages for intervention staff. Tied to specific job descriptions (Dietetic Technician vs. Registered Nurse), the low and high entries are based on national median (2016) hourly wages available from the Bureau of Labor Statistics and are adjusted for fringe benefits using national 2016 rates (31.5%).(18, 19)

To capture the impact of parameter variability on our study results, we conducted probabilistic sensitivity analyses. Using a non-parametric bootstrap technique(20), the model was run 10,000 times, each time resampling the following parameters from the original Fit Blue trial data with replacement: cost of phone and self-monitoring sessions, cost of meal replacements, and outcome measures. This non-parametric method allowed us to avoid making distributional assumptions about the parameter in question.(20) Probabilistic sensitivity analyses were used to estimate 95% confidence ellipses representing the uncertainty surrounding costs and effects and to compute cost-effectiveness acceptability curves (CEACs), which plot the percentage of iterations for which a condition is preferred over its alternative for a range of willingness-to-pay levels.

Results

Out of 124 CI participants, 66 (53.2%) attended at least 75% of 56 possible phone sessions and self-monitoring feedback (at least 42 interactions). Out of 124 SP participants, 8 (6.5%) requested any sessions or feedback. The probability of weight loss ≥5% of initial body weight was greater in the CI (22.6%) than in the SP condition (9.7%) (p-value = 0.0057). The probability of lost to follow-up at 12 months was 23.4% in the CI condition, and 37.9% in the SP condition (p-value = 0.0132). Figure 1 shows the detailed decision-tree including path probabilities.

Overall intervention costs differed substantially between the two conditions. CI was estimated to cost overall approximately $133,986 and $1,080.53 per participant, while SP was estimated to cost overall approximately $14,845 and $119.72 per participant (Table 1). Most of this difference can be attributed to interventionists' time costs, because there were a greater number of phone sessions and self-monitoring emails among CI participants. A portion of the difference can also be attributed to meal replacements which were not available to SP participants.

Introductory pay for interventionists was $45,000 per year, or $21.63 per hour. Including institutional fringe benefits, the total cost of each interventionist was $28.94 per hour. The cost of meal replacements was calculated based on the number of meal replacements consumed multiplied by the average cost per meal replacement of $5.08. Participant materials differed slightly between the two conditions, resulting in slightly higher costs for CI ($129.11) compared to SP ($104.21; see Table 1).

CI participants experienced significantly better clinical outcomes compared to SP participants. Including baseline observations carried forward for missing values, the mean weight loss was 1.86 kg among CI participants compared to 0.06 kg among SP participants (p-value = 0.0004). CI participants achieved a mean reduction in waist circumference of 1.85 cm compared to 0.48 cm for those in the SP condition (p-value = 0.0240). CI participants did not achieve significantly more QALYs at 12 months; 0.87 QALYs compared to 0.85 QALYs for SP participants (p-value = 0.3879).

Results of the base-case cost-effectiveness analyses are presented in Table 2. While costs were the same for all outcome measures, ICERs were different due to different denominators: weight loss in kg, waist circumference reductions in cm, and QALYs. The ICERs for CI relative to SP were $533.31 per kg lost, $698.77 per cm reduction in waist circumference, and $61,267.50 per additional QALY.

One-way sensitivity analysis showed that the model was relatively sensitive to interventionists' wages. For hourly wages + fringe ranging from $16.66 (Dietetic Technician) to $43.28 (Registered Nurse)(18, 19) the expected intervention costs ranged from $119.06 to $120.49 in the SP condition and from $813.90 to $1,392.91 in the CI condition. The ICERs for CI relative to SP ranged from $385.67 to $706.26 per kg lost, from $505.33 to $925.39 per cm reduction in waist circumference, and from $44,307.32 to $81,137.53 per additional QALY.

Probabilistic sensitivity analyses conducted with non-parametric bootstrap resampling revealed uncertainties surrounding the cost-effectiveness results. The incremental cost-effectiveness scatterplots depicted in Figures 2-4 show the differences in mean costs and outcome measures for CI versus SP from 10,000 bootstrap replicates. These scatterplots highlight the uncertainty in cost and outcome estimates associated with CI relative to SP.(21)

Each dot in the graphs represents the incremental cost (y-axis) and incremental effectiveness (x-axis) of CI relative to SP for a single iteration of the decision tree. The cost effectiveness acceptability curves (CEACs) were drawn from these joint distributions of incremental costs and incremental effects derived from the non-parametric bootstrap resampling. The curves highlight uncertainty in the ICER estimates by plotting the probabilities that the CI condition is cost-effective relative to the SP condition at varying levels of the willingness-to-pay or cost-effectiveness threshold.(21) The weight loss CEAC indicates a 49% probability that CI is cost-effective when the willingness-to-pay threshold is set at our base case ICER ($533 per additional kg of weight loss) but approaches 80% for larger willingness-to-pay thresholds (Figure 2). The CEAC for reduction in waist circumference suggests a 51% probability that CI is cost-effective when the willingness-to-pay threshold is set at our base case ICER ($699 per additional cm of reduction in waist circumference) but approaches 70% at higher willingness-to-pay thresholds (Figure 3). At a willingness-to-pay of $50,000 per additional QALY achieved, the probability CI is cost-effective is 45%, and at a willingness to pay of $100,000 the probability rises to 49%. The probability CI is cost-effective in terms of QALYs approaches 52% at higher willingness-to-pay thresholds (Figure 4).

Discussion

This study assessed the cost-effectiveness of two adaptations of the Look AHEAD ILI in a US military setting. Several of the findings are notable and worth further discussion. Compared to SP participants, CI participants accumulated higher average costs but achieved better outcomes which may help to reduce turnover in the military, saving the cost of recruitment and training. The observed reduction in waist circumference is particularly notable because waist circumference has been described as an important predictor of obesity-related health risks, including risk for diabetes, coronary heart disease, and stroke.(22) Reduction in waist circumference is also of particular relevance to the Air Force military branch since abdominal circumference is currently included in their fitness assessment.(23) Given the estimated recruitment and training costs of $75,000 per enlistee(11) and the total costs of the CI intervention of approximately $133,986, the CI intervention would have saved money if participation in the intervention prevented two CI participants from being discharged due to fitness test failures.

Although significantly better clinical outcomes among CI participants relative to SP at 12 months did not translate into significantly more QALYs at 12 months, a significant impact on QALYs was unlikely over such a short time horizon. Ackermann et al.(24) assessed the impact of weight changes on health-related quality of life in the Diabetes Prevention Program (DPP) and found that weight-related changes in quality of life scores were very small after one year (0.007 increase for every 5 kg weight loss). We would expect however, that if the improvements made in the clinical outcomes (weight loss and reduction in waist circumference) are sustained, then in the future, the difference in QALYs would be greater between the two groups.

Depending on the willingness-to-pay, the CI intervention can be deemed cost-effective. In our base case cost-effectiveness analysis of the CI relative to the SP condition, ICERs for clinical outcome measures were $533.31 per kg lost and $698.77 per cm reduction in waist circumference. Thus, if the decision maker is willing to pay at least $533.31 per additional kg weight loss or $698.77 per additional cm reduction in waist circumference, CI would be considered cost-effective relative to SP. In the past, the figure of a lifetime cost of $50,000 per QALY has been used as society's threshold to determine the cost-effectiveness of a given healthcare intervention. However, in recent years there has been a call for a much higher willingness-to-pay threshold and $100,000 and even $150,000 per QALY are being used.(25) In our base-case analysis, the ICER for CI relative to SP was in below thresholds at $61,267.50 per additional QALY. Thus, CI would be considered cost-effective at a willingness-to-pay of $100,000 and $150,000. It is important to note, however, that in our analysis we estimate costs per QALY over one year for a health system and are unable to provide data from a societal perspective.

A meta- and cost effectiveness analysis of commercial weight loss interventions reported an ICER of $155 (2013 US dollars) per kg of weight loss for Weight Watchers relative to a low-cost control intervention.(26) While this suggests that Weight Watchers is more cost-effective than the CI adaptation,it is unclear how effective a commercial weight loss intervention would be in a military population. For example, the participants in the Fit Blue trial were considerably younger (mean 35 years old),face severe occupational consequences related to their physical fitness and bear significant stress related to potential deployments. Military-specific characteristics and challenges that may influence the weight loss intervention success in this setting have been described elsewhere.(14, 15)

We examined two adaptations of the Look AHEAD intervention tailored to a military setting. The Look AHEAD ILI was modeled after the DPP, but included several modifications, such as more ambitious nutritional targets, and produced superior weight loss after 1 year.(27) Despite the differences the two programs also share many features including intervention sessions focusing on similar topics and the inclusion of toolbox strategies.(27) The DPP has been reported as cost-effective relative to a placebo intervention among adults with impaired glucose tolerance.(28, 29) While costs of the more recent Look AHEAD clinical trial have been reported, to date, cost-effectiveness analysis, addressing both costs and outcomes has not yet been conducted.(30) While several adaptations of the DPP and Look AHEAD interventions have been successfully translated into different settings(31-35), only a few studies have included economic evaluations(31-33).

The present study is unique because it presents an economic evaluation of a weight loss intervention in the US military setting. There have been few randomized controlled trials of behavioral weight loss or weight management interventions in the US military setting and economic evaluations have not been conducted alongside these trials.(36-38) To our knowledge, the present study is the first to conduct a cost-effectiveness analysis of a weight loss intervention in the US military setting.

Our study results should be interpreted with caution. While the base-case ICERs suggest that CI could be considered cost-effective, the computed ICERs were sensitive to interventionist wages. Further, probabilistic sensitivity analysis identified uncertainty around our cost-effectiveness estimates. QALYs have become the preferred method to measure effectiveness in cost-effectiveness analysis. Nevertheless, the use of QALYs has also been criticized because the thresholds used to infer cost-effectiveness are arbitrary and the methodology used to estimate QALYs are usually based on subjects' responses to a questionnaire; therefore representing their perceived value of their health status.(17, 39) In addition, a one-year time horizon, as was utilized in our analysis, may not be adequate to detect changes in QALYs because weight loss may not translate to improvements in quality of life over such a short time-horizon. Over a one-year time horizon, a clinical measure, such as the reduction in waist circumference, may be more relevant to the Air Force branch since this measure is part of the fitness assessment. For these reasons, we conducted analyses with other clinical outcome measures (kg weight loss and cm waist circumference reduction) that may be of interest to a decision maker. However, without established benchmarks, they do not allow for objective assessments of cost-effectiveness.

Like many behavioral intervention trials, missing follow-up information was a concern. Best-practices approaches were implemented to minimize impact on our analyses. Our study time horizon (12 months) was relatively short, limiting our ability to track longer-term health outcomes. However, 12-month follow-up is common for the weight-loss and weight management interventions.(40, 41) Since the original Fit Blue trial did not include a no-intervention control group, it is unclear how the CI intervention may have performed relative to a true control population over the 12-month study period. A previous study suggests that Air Force service members not receiving any intervention gain weight over a one-year period.(37) Finally, the Fit Blue intervention was implemented in an Air Force setting; our study results may not be generalizable to other military branches or the general population.

Conclusion

The CI adaptation of the Look AHEAD Intensive Lifestyle Intervention was cost-effective relative to the SP adaptation at a willingness-to-pay of $100,000 per QALY. While ICERs for clinical outcome measures were calculated, established cost-effectiveness thresholds do not exist for these metrics. Our analyses indicate that they could be deemed cost-effective across a wide range of willingness-to-pay thresholds. Future studies with a larger sample size, a longer follow-up period, and non-intervention control group are needed to address limitations of the current analysis.

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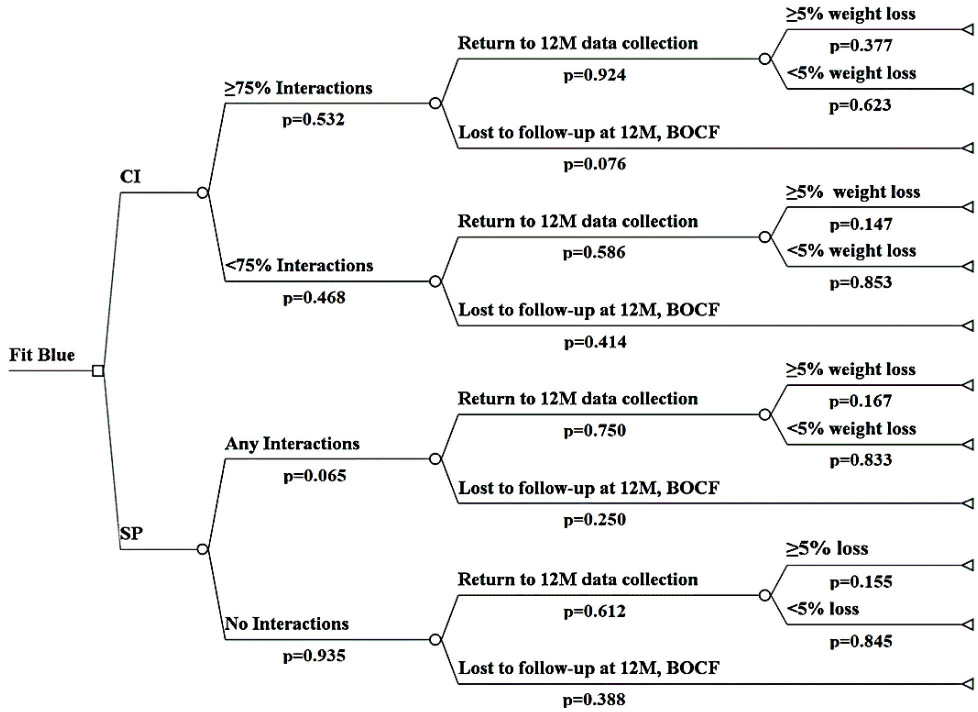
Tables and Figures

Table 1 - Summary of Costs for participants in the CI and SP condition (in 2016 USD)

	CI condition (n=124)		SP condition (n=124)	
Cost Variables	Total cost	Per person cost	Total cost	Per person cost
Materials				
Scale	$ 11,780.00	$ 95.00	$ 11,780.00	$ 95.00
Cups and Spoons	$ 582.80	$ 4.70	$ 582.80	$ 4.70
Binder	$ 2,647.40	$ 21.35		
Toolbox	$ 1,000.00	$ 8.06		
T-Shirt			$ 559.24	$ 4.51
Total materials costs	$ 16,010.20	$ 129.11	$ 12,922.04	$ 104.21
Challenge Prizes				
T-Shirt	$ 293.15	$ 4.51		
Shoe Laces	$ 144.00	$ 4.00		
Blender Bottle	$ 128.00	$ 8.00		
Reflective Bands	$ 12.00	$ 4.00		
Total Challenge Prizes costs	$ 577.15	Mean: $ 4.65 Range: $ 0 – $ 20.51		
Meal Replacements				
Total Meal Replacements costs	$ 37,177.98	Mean: $ 299.82 Range: $ 0 - $ 1,600.20		
Phone and Self-monitoring Sessions				
Total Phone and Self-monitoring Sessions costs	$ 78,118.22	Mean: $ 629.99 Range:$57.84 - $2,158.88	$ 193.28	Mean: $ 1.56 Range: $ 0 - $ 67.48
Data Collection Incentives				
4 month incentive: Pedometer	$ 1,722.20	$ 15.80	$ 1,422.00	$ 15.80
12 month incentive: Water Bottle	$ 380.00	$ 4.00	$ 308.00	$ 4.00
Total Data Collection Incentives costs	$ 2,102.20	Mean: $16.95 Range: $ 0 - $ 19.80	$ 1,730.00	Mean: $ 13.95 Range: $ 0 - $ 19.80
Total One Year Costs	$ 133,985.75	Mean: $ 1,080.53 Range: $ 186.95 - $ 2,788.74	$ 14,845.32	Mean: $ 119.72 Range: $ 104.21 - $ 191.49

Table 2 - Summary of costs, effects, and cost-effectiveness for CI and SP conditions.

Outcome measure at 12 month	CI condition	SP condition	Difference	ICER Point Estimate
Costs per person, in 2016 USD	1,080.53	119.72	960.81	N.A.
Weight Loss, in kg	1.857	0.056	1.802	533.31
Reduction in Waist Circumference, in cm	1.853	0.478	1.375	698.77
QALY (one-year only)	0.871	0.856	0.016	61,267.50



Path Probabilities	Mean costs	Mean weight loss	Mean waist circumferene reduction	Mean QALYs at 12M	Mean change in QALYs from baseline
0.185	$ 1,416.27	-7.75 kg	-7.44 cm	0.85	-0.03
0.306	$ 1,349.28	-1.01 kg	-1.57 cm	0.86	-0.05
0.040	$ 1,060.66	± 0 kg	± 0 cm	0.87	± 0
0.040	$ 719.59	-6.28 kg	-5.14 cm	0.92	+0.04
0.234	$ 853.29	+0.61 kg	+0.92 cm	0.86	-0.02
0.194	$ 687.17	± 0 kg	± 0 cm	0.92	± 0
0.008	$ 131.24	-5.70 kg	-2.86 cm	0.84	-0.04
0.040	$ 149.07	-1.38 kg	-2.86 cm	0.90	-0.01
0.016	$ 142.48	± 0 kg	± 0 cm	0.98	± 0
0.089	$ 121.14	-7.72 kg	-6.89 cm	0.85	-0.05
0.484	$ 120.85	+1.51 kg	+0.53 cm	0.81	-0.08
0.363	$ 113.34	± 0 kg	± 0 cm	0.91	± 0

Figure 1. – Tree structure used in the decision model with probability paths, costs and outcome measures for each branch. For participants who did not return for the final 12 month data collection, BOCF indicates baseline observation carried forward.

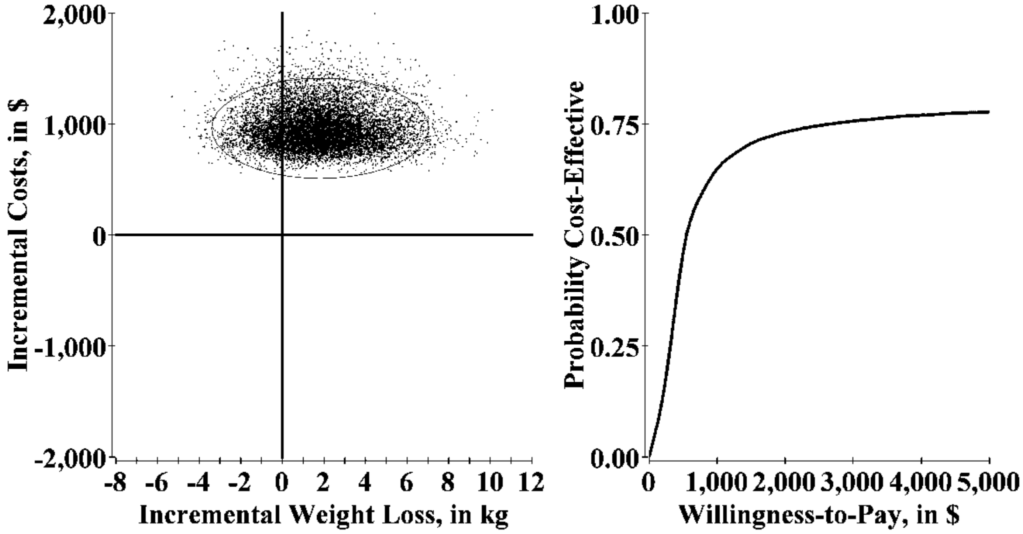


Figure 2. - Plot of 10,000 bootstrap replicates of the incremental costs per kilogram of weight loss and cost-effectiveness acceptability curve representing the proportion of simulations for which the CI intervention was preferred at a given willingness-to-pay threshold.

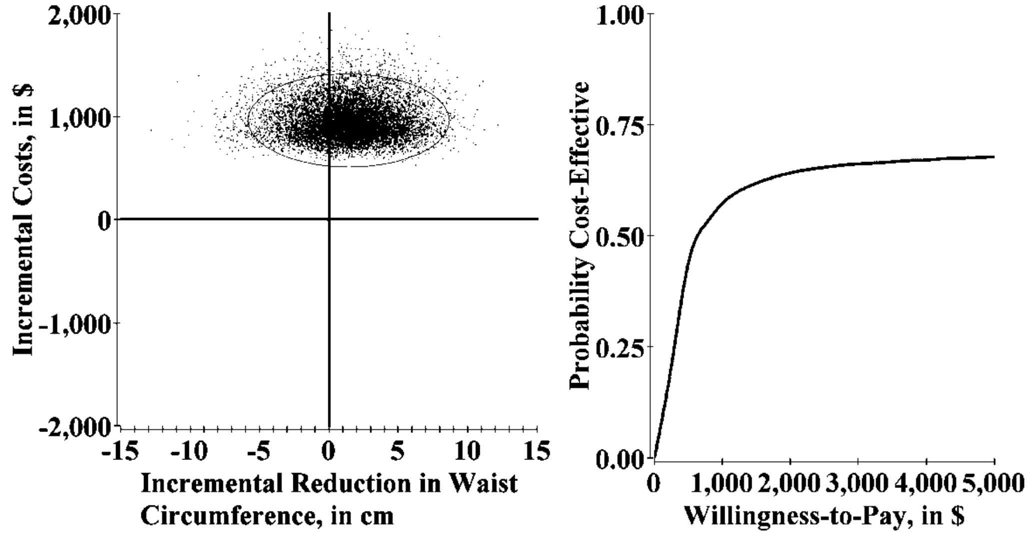


Figure 3. - Plot of 10,000 bootstrap replicates of the incremental costs per centimeter reduction of waist circumference and cost-effectiveness acceptability curve representing the proportion of simulations for which the CI intervention was preferred at a given willingness-to-pay threshold.

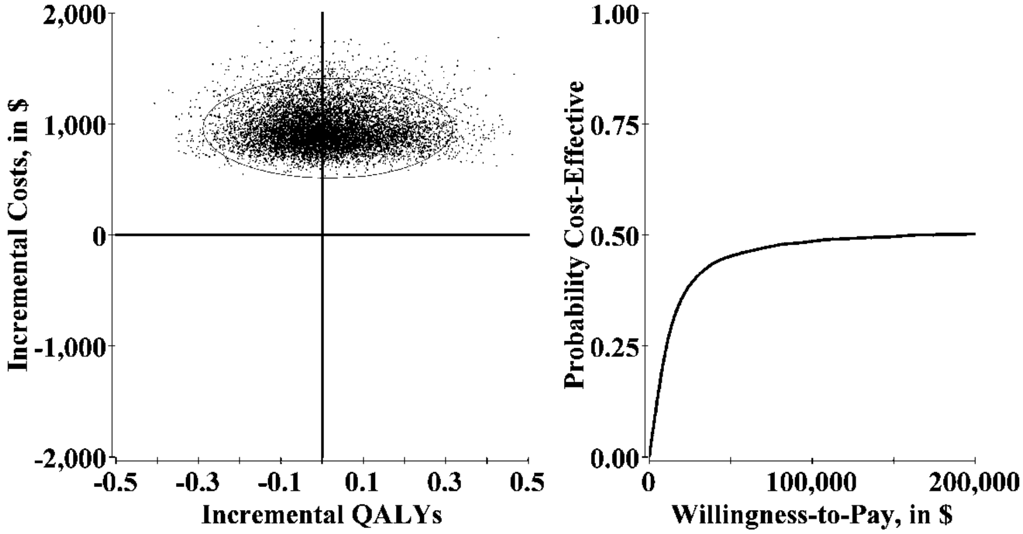


Figure 4. - Plot of 10,000 bootstrap replicates of the incremental costs per QALY and cost-effectiveness acceptability curve representing the proportion of simulations for which the CI intervention was preferred at a given willingness-to-pay threshold.

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Biographical Sketch

Karina C. Manz grew up in Hardt, Baden-Württemberg, Germany. She attended Fulda University of Applied Sciences in Fulda, Germany before transferring to Morehead State University in Morehead, Kentucky where she graduated *summa cum laude* with a Bachelor's degree in Health Promotion in May 2016. In the fall of 2017, she came to the University of Kentucky in Lexington, Kentucky to obtain her Master of Public Health degree with a concentration in Epidemiology.

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