ARTICLE

The Economic Effect of Planet Health on Preventing Bulimia Nervosa

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Objectives: To assess the economic effect of the school-based obesity prevention program Planet Health on preventing disordered weight control behaviors and to determine the cost-effectiveness of the intervention in terms of its combined effect on prevention of obesity and disordered weight control behaviors.

Design: On the basis of the intervention's short-term effect on disordered weight control behaviors prevention, we projected the number of girls who were prevented from developing bulimia nervosa by age 17 years. We further estimated medical costs saved and quality-adjusted life years gained by the intervention over 10 years. As a final step, we compared the intervention costs with the combined intervention benefits from both obesity prevention (reported previously) and prevention of disordered weight control behaviors to determine the overall cost-effectiveness of the intervention.

Setting: Middle schools.

Participants: A sample of 254 intervention girls aged 10 to 14 years.

Intervention: The Planet Health program was implemented during the school years from 1995 to 1997 and was designed to promote healthful nutrition and physical activity among youth.

Main Outcome Measures: Intervention costs, medical costs saved, quality-adjusted life years gained, and cost-effectiveness ratio.

Results: An estimated 1 case of bulimia nervosa would have been prevented. As a result, an estimated $33 999 in medical costs and 0.7 quality-adjusted life years would be saved. At an intervention cost of $46 803, the combined prevention of obesity and disordered weight control behaviors would yield a net savings of $14 238 and a gain of 4.8 quality-adjusted life years.

Conclusions: Primary prevention programs, such as Planet Health, warrant careful consideration by policy makers and program planners. The findings of this study provide additional argument for integrated prevention of obesity and eating disorders.

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BULIMIA NERVOSA (BN) IS A well-recognized eating disorder (ED) in the United States; some 3% to 5% of young women suffer from partial- or full-syndrome BN.[1,2] Persons with BN may manifest elevated levels of anxiety,[3] impulsivity,[3,4] and self-injurious behavior.[4] There are considerable medical, social, and functional burdens that accompany the disorder.[2,5] Typically, the disorder develops in adolescence, and individuals with a partial syndrome, such as binge eating, purging, or using diet pills, are at risk of developing the full syndrome. Because disordered weight control behaviors (DWCB), such as purging or using diet pills, are often positively associated with overweight and obesity in adolescents,[6-9] there has been growing interest in integrating the prevention of obesity and EDs.[10-13]

To test the effectiveness of this type of integration, 1 recent study examined the effect of Planet Health, an interdisciplinary, school-based obesity prevention intervention, on preventing DWCB in early adolescence.[14] The intervention was first shown to be effective in preventing and reducing obesity in early adolescent girls in a randomized controlled trial (RCT) in 10 middle schools conducted over 2 years.[15] As an interdisciplinary curriculum, intervention material was infused into physical education and 4 major subject areas. Students in the control schools received usual curricula and physical education classes. A second study based on the same RCT data found that the Planet Health intervention had an unanticipated effect of preventing DWCB among early adolescent girls. After the 2-year intervention, girls in the intervention schools were less likely to report DWCB at follow-up compared with girls in the control schools.[14] The findings of the 2 studies suggested that Planet Health was effective in preventing both obesity and DWCB among early adolescent girls. The DWCB preventive effect was replicated in a subsequent RCT of Planet Health conducted in 13 middle schools over 2 years.[16]

Table 1. Two-Year Intervention Costs of Planet Health (in 2010 Dollars)[a]

Item	Quantity	Unit Cost, $	Total Cost, $
Training workshop			
Trainer	1 d each year for each of the 5 schools	Annual salary 52 812	2031
Assistant trainer	1 d each year for each of the 5 schools	Annual salary 40 304	1550
Teacher reimbursement			
Subject teachers	3 h of training for 101 teachers in each of the 2 y	34.74 per hour	21 055
Physical education teachers	5 h of training for 9 teachers in first year and 3 h in second year	34.74 per hour	2502
Food	110 teachers each year	13.90 per teacher	3058
Teacher wellness activities			
Trainer	6 sessions, 1 h in duration, for each of the 5 schools	41.70 per hour	1251
Fitness funds	5 schools	694.90 per school per year	6949
Planet Health book	1 copy for each of 110 teachers	76.44 per book	8408
Total	. . .	. . .	46 803

[a]Values are provided by Harvard Prevention Research Center. Data do not sum to total due to rounding.

The results of the first RCT were used to conduct an economic evaluation of Planet Health in preventing obesity. A full description of the intervention costs and its cost-effectiveness in preventing obesity is available elsewhere.[17] In brief, at an intervention cost of $46 803 (**Table 1**), the Planet Health program would prevent an estimated 6 girls from becoming overweight/obese adults. As a result, an estimated $27 042 in medical costs and 4.1 quality-adjusted life years (QALYs) would be saved. In the present analysis, we focused on assessing the economic effect of Planet Health on preventing DWCB. As a final step, we compared the intervention costs with the combined intervention benefits from obesity prevention and DWCB prevention to determine the overall cost-effectiveness of the intervention.

METHODS

OVERVIEW OF STUDY DESIGN

Because decisions to pursue certain health education programs in schools are usually made by policy makers in the interest of society as a whole, the societal perspective was adopted in this study. This study was conducted in 5 steps. First, we projected the number of girls prevented from developing BN by age 17 years. Second, we estimated medical treatment costs saved over 10 years. Third, we estimated QALYs gained over 10 years. Fourth, we conducted sensitivity analyses on all main parameters. Fifth, we combined the medical costs saved and QALYs gained by Planet Health from both obesity prevention and DWCB prevention and assessed the cost-effectiveness of the intervention in terms of its combined effects. All costs were adjusted to 2010 US dollars. Medical costs and QALYs were discounted by 3%.

NUMBER OF GIRLS PREVENTED FROM DEVELOPING BN BY AGE 17 YEARS

On the basis of the efficacy results of the Planet Health RCT, 14 of 226 girls (6.2%) in control schools and 7 of 254 girls (2.8%) in intervention schools reported DWCB at follow-up. Without the intervention, 6.2% of girls in the intervention schools would be expected to have DWCB at the follow-up at age 13.5 years. In other words, 3.4% of girls in the intervention schools would be prevented from developing DWCB. Because DWCB are often precursors to BN, prevention of DWCB would lead to prevention of BN cases.

We reviewed published studies on symptom development in BN to obtain estimates for progression duration and progression probability. One study on symptom development showed that young women with BN typically reported symptom onset during their teen years (ages 15-19 years) and reported 3.5 years as the time from the onset of BN symptoms to the onset of BN.[18] Thus, in this study, we used 3.5 years as the time for symptom development and projected the number of girls prevented from developing BN by age 17 years.

During the past 2 decades, a number of follow-up studies have investigated the progression from disordered eating behaviors to the onset of BN.[19-23] As shown in **Table 2**, these studies displayed heterogeneity in sample characteristics, follow-up interval, and baseline symptoms. Although the diagnostic criteria used for BN at follow-up were generally the same across studies (*Diagnostic and Statistical Manual of Mental Disorders* [*DSM*]–*III-R* and *DSM-IV*), the classifications of disordered eating behaviors at baseline were different. The classifications generally belonged to 2 categories: subthreshold ED (individuals who experience all the symptoms of a particular ED but experience subthreshold levels of 1 or more symptoms) and partial ED (individuals who report only a subset of the symptoms of a particular ED).[16] In this study, we used the term *subdiagnostic ED* (SED) to refer to individuals who have either subthreshold ED or partial ED (eg, met all features for BN except the frequency or duration or report purging but not binge eating or vice versa). As shown in Table 2, the reported progression probabilities indicate that individuals with SED would have a 17% to 44% chance of developing BN. We used the probability of 30.5% (middle point of 17% and 44%) for the base-case analysis and used the range of 17% to 44% for the sensitivity analyses.

Because the Planet Health study questionnaires assessed only DWCB in the previous month and did not include a diagnostic instrument, the percentage of participants who could have been classified as having SED is unknown. To be conservative, we assumed that 50% of the girls with DWCB in the Planet Health study had SED, ranging from 25% to 75%. We used 50% for the base-case analysis and used the range of 25% to 75% for the sensitivity analyses.

MEDICAL TREATMENT COSTS SAVED PER BN CASE PREVENTED OVER 10 YEARS

Patients with BN are typically treated in outpatient settings with cognitive behavior therapy, interpersonal therapy, and pharmacotherapy; only a small percentage are hospitalized. **Table 3** summarizes the literature on the reported medical costs for BN treatment in the United States; all costs were adjusted to 2010

Table 2. Percentage of Girls Who Are Symptomatic and Develop BN at Follow-up

Source	Sample			Follow-up Period, y	Disordered Eating Behavior at Baseline		BN at Follow-up, %
	No. of Participants	Population	Age Range at Baseline, y		Behavior	No.	
Stice et al[19]	496	Community sample of adolescent girls (United States)	12-15	8.0	BED	24	42.0
					Subthreshold BN	30	17.0
Yager et al[20]	628	National sample of women (United States)	17-32	1.7	SED	202	32.7
Herzog et al[21]	33	Patients with SED (United States)	17-34	3.5	SBN	15	40.0
					SAN/SBN or SBN	25	44.0
King[22]	96	General practice population (England)	15-34	1.0-1.5	PBN	15	20.0
Milos et al[23]	192	Patients with ED (Switzerland)	17-50	1.0	EDNOS	29	24.1

Abbreviations: BED, binge eating disorders; BN, bulimia nervosa; ED, eating disorder; EDNOS, eating disorders not otherwise specified; PBN, partial BN; SAN, subdiagnostic anorexia nervosa; SBN, subdiagnostic BN; SED, subdiagnostic eating disorders.

Table 3. Medical Treatment Costs for BN (2010 US Dollars)

Source	No. of Participants	Age, y	Population	Treatment Procedure (Period of Treatment)	Cost per Patient, $
Koran et al[24]	71	29.6	Female BN	Medication (16 wk)	1443
				Medication (24 wk)	1837
				Medication/CBT (15 wk)	4085
				Medication/CBT (16 wk) + medication (8 wk)	4478
				CBT (15 wk)	2863
Striegel-Moore et al[25]	721	27.9	Female BN	Inpatient (14.7 d)	16 138
				Outpatient (15.6 d)	3341
				Inpatient and outpatient combined (annual)	5260
Reas et al[26]	44	21.1	Female BN/SBN	Initial treatment: CBT	
				Psychiatric and medical for 9 y	
				73% recovered	23 985
				27% not recovered	76 760
				Average	42 833

Abbreviations: BN, bulimia nervosa; CBT, cognitive behavior therapy; SBN, subdiagnostic BN.

US dollars using the medical care component of the consumer price index. In a cost-effectiveness study, Koran et al[24] reported projected costs for 5 types of psychiatric treatments for BN patients. Using a national insurance database, Striegel-Moore et al[25] reported average annual inpatient and outpatient treatment costs. To date, only the study by Reas et al[26] has provided a long-term medical cost estimate for BN treatment. In this present study, we projected cumulative costs over 10 years on the basis of the cost estimates generated in the previously mentioned 3 studies.

First, we estimated 10-year cumulative costs on the basis of cost estimates by Koran and Striegel-Moore and their colleagues. We chose to use the costs of cognitive behavior therapy and the costs of inpatient and outpatient treatment combined as the typical costs of BN treatment because the former represents the most cost-effective approach to the treatment of BN[27] and the latter best represents the treatment costs of an average BN patient. Because typical cognitive behavior therapy treatments involve 20 outpatient sessions,[26,27] we adjusted the cost estimates by Koran and Striegel-Moore and their colleagues from 15 and 15.6 sessions, respectively, to 20 sessions.

Because treatment for BN is often associated with a chronic course, we incorporated the probability of an average patient requiring treatment each year to project long-term costs over 10 years. A recent 7-year follow-up study by Eddy et al[28] examined the longitudinal course and crossover for participants with an intake diagnosis of anorexia nervosa and BN. The authors of this study kindly provided us the full recovery rates for each of the 7 years (0, 19%, 29%, 40%, 43%, 47%, and 50%) (written communication, December 2010). We assumed that a BN patient would require treatment if he or she is not fully recovered during each 1-year interval, and if a patient is not fully recovered in year 7, he or she will not recover in the next 3 years. On the basis of those probability estimates and the cost estimates by Koran and Striegel-Moore and their colleagues, we estimated cumulative costs per patient over 10 years (discounted to age 13.5 years).

Second, we projected 10-year treatment costs on the basis of Reas et al's average treatment costs over 9.3 years. We first calculated annual costs per BN patient and then estimated cumulative costs per BN patient over 10 years (discounted to age 13.5). Third, we calculated the average of the 10-year cumulative cost estimates generated as described previously. We used the average for our base-case analysis and used the range of the estimates for sensitivity analyses.

QALYs GAINED PER BN CASE PREVENTED OVER 10 YEARS

Several studies have examined the association between ED and health-related quality of life (HRQL) using various HRQL in-

Table 4. Recovery/Remission, Relapse, and Recovery From Relapse in Bulimia Nervosa

Source	No. of Participants	Age, y	Duration of Follow-up, y	Time to Recovery/ Remission, y	Rate of Recovery/ Remission, %	Rate of Relapse, %	Probability of Recovering From Relapse, %
Clausen et al[36]	123	20.9	2.5	1.7	35	NR	NR
Grilo et al[37]	23	31.1	5.0	5.0	74	47 (within 5 y)	NR
Herzog et al[38]	110	24.8	7.5	7.0	73	35.3	NR
Keller et al[39]	30	23.9	3.5	3.0-3.5	69	63 (after 1.5 y recovery)	50
Reas et al[26]	44	30.5	9.3	9.3	73	NR	NR

Abbreviation: NR, not reported.

struments and have reported that HRQL impairment occurs in patients with ED as well as those with SED.[29-33] However, the HRQL measures used in those studies are not preference weighted and cannot be converted into QALY measures.[34] Nevertheless, 1 recent cost-utility study by Pohjolainen and colleagues[35] used the preference-weighted 15D, a generic, comprehensive, self-administered instrument for measuring and assessing HRQL among BN patients. The 15D can be used as a profile and a single index measure. A set of utility or preference weights, elicited from the general public, is used to generate a utility score across 15 dimensions on a 0 to 1 scale. As a preference-weighted measure, the utility score can be used to calculate QALYs. Pohjolainen et al reported that the mean (SD) HRQL is 0.80 (0.09) among BN patients and 0.85 (0.10) among BN patients after 6 months of treatment, and the mean HRQL is 0.96 in the general population.

Several prospective studies have investigated rates of recovery and relapse in BN.[26,36-39] **Table 4** displays the published rates of recovery/remission, relapse, and recovery from relapse in BN. The reported rate of recovery varies across studies, but it generally increases as the duration of follow-up increases. Three studies reported a similar recovery rate (73%-74%) but a different time to recovery (5, 7, and 9.3 years).[26,37,38] In our base-case analysis, we assumed 73% will recover in 7 years. For BN patients who have recovered, we assumed that the HRQL score improves linearly over 7 years from 0.85 to 0.96 and remains 0.96 for the next 3 years. For those who have not recovered, we believe treatment can improve their quality of life but not as much as for those who have recovered. An early study on the effect of treatments showed that patients with severe symptoms of ED could improve their social functioning scores after 2 years of treatment, but their scores remained significantly below those of a general population.[40] On the basis of this finding, we assumed that the HRQL score for those who have not recovered at the end of 7 years improves linearly over 7 years from 0.80 to 0.85 and remains 0.85 for the next 3 years. In the sensitivity analyses, we varied the HRQL estimates in a range from –1 SD to +1 SD and varied the time to recovery from 5 to 10 years.

SENSITIVITY ANALYSES

In our base-case analysis, there is uncertainty caused by the assumptions we made as well as the parameter estimates derived in previously published studies. To test how uncertainty in those assumptions and parameters affected the main results, we conducted both univariate and multivariate sensitivity analyses on 5 parameters: percentage of girls with DWCB who had SED, progression probability, medical treatment costs, HRQL of BN patients, and time to recovery. In the univariate analysis, we varied 1 variable at a time. In the multivariate analysis, Monte Carlo simulation of 10 000 trials was performed using @RISK (Palisade Corporation, Newfield, New York). Parameter values for each simulation trial were selected randomly from a plausible range identified, assuming a triangular distribution of values for each parameter.

Table 5. Base-Case Analysis Results

Variable	Value
Percentage of girls with DWCB at age 13.5 y, control	6.2
Percentage of girls with DWCB at age 13.5 y, intervention	2.8
No. of girls prevented from developing DWCB at age 13.5 y	8.6
Percentage of girls with DWCB who had SED	50.0
No. of girls prevented from developing SED	4.3
Progression probability from SED to BN by age 17 y, %	30.5
No. of girls prevented from developing BN at age 17 y	1.3
Cumulative medical costs over 10 y per BN patient, $	26 154
Total medical treatment costs saved by Planet Health, $	33 999
QALYs per BN patient over 10 y	6.9
QALYs lost per BN patient over 10 y compared with a person without an eating disorder	0.5
Total QALYs gained by Planet Health	0.7

Abbreviations: BN, bulimia nervosa; DWCB, disordered weight control behaviors; QALY, quality-adjusted life year; SED, subdiagnostic eating disorders.

RESULTS

Under base-case assumptions, at age 13.5 years, 4 girls in the intervention scenario and 8 girls in the control scenario would have been expected to have SED. By age 17 years, 1 girl in the intervention scenario and 2 girls in the control scenario would develop BN. In other words, an estimated 1 girl would have been prevented by Planet Health from developing BN by age 17. **Table 5** shows the base-case analysis results.

The estimated cumulative costs per patient over 10 years are $18 492 to $20 656 for cognitive behavior therapy treatment, $30 040 for inpatient and outpatient treatment combined, and $35 427 based on self-reported long-term costs. The average cumulative costs per patient over 10 years are $26 154. The discounted QALYs over 10 years are 7.1 for a patient who is recovered at the end of 7 years, 6.4 for a patient who is not recovered, 6.9 for an average BN patient, and 7.4 for an average person without an ED. The discounted QALYs gained per BN case prevented over 10 years are 0.5. The total treatment costs prevented by the intervention due to preventing DWCB were $33 999, and the total QALYs gained by the intervention were 0.7.

Table 6. Results of Sensitivity Analyses

Type of Analysis	No. of Girls Prevented From Developing BN by Age 17 y	Total Medical Costs Saved by Planet Health, $	Total QALYs Gained by Planet Health
Univariate			
Percentage of girls with DWCB who had SED (25%-75%)	0.7-2.0	18 307-52 308	0.33-0.99
Progression probability (17%-44%)	0.7-1.9	18 307-49 692	0.37-0.95
Long-term medical costs per BN patient ($18 492–$35 427)	1.3	24 040-46 056	0.66
HRQL of an average BN patient (without treatment: 0.71-0.89, with treatment: 0.75-0.95)	1.3	33 999	0.10-1.20
Time to recovery (5-10 y)	1.3	33 999	0.55-0.79
Multivariate	0.7-2.1	17 570-58 962	0.20-1.32

Abbreviations: BN, bulimia nervosa; DWCB, disordered weight control behaviors; HRQL, health-related quality of life; QALY, quality-adjusted life year; SED, subdiagnostic eating disorders.

Table 7. Cost-effectiveness of Planet Health in Preventing Obesity and DWCB

Variable	Base-Case Value (Range)
Intervention costs, $	46 803
Medical costs saved, $	
Obesity prevention	27 042 (16 291 to 35 085)
DWCB prevention	33 999 (17 570 to 58 962)
Obesity and DWCB prevention combined	61 041 (33 861 to 94 047)
QALYs gained	
Obesity prevention	4.1 (2.3 to 10.4)
DWCB prevention	0.7 (0.2 to 1.3)
Obesity and DWCB prevention combined	4.8 (2.5 to 11.7)
Cost-effectiveness ratio, $ per QALY gained	–2966 (5177 to –4038)

Abbreviations: DWCB, disordered weight control behaviors; QALY, quality-adjusted life year.

Table 6 summarizes results from sensitivity analyses. From the univariate analysis, we found that our results were generally sensitive to most of the parameter estimates used, except the estimate for time to recovery. In 95% of the 10 000 simulation trials of the multivariate analysis, medical costs saved by the intervention ranged from $17 570 to $58 962, and QALYs gained ranged from 0.2 to 1.3.

Table 7 summarizes the economic effect of Planet Health on obesity prevention and DWCB prevention. As the intervention's overall effect, an estimated $61 041 would be saved in medical costs and an estimated 4.8 QALYs would be gained. At an intervention cost of $46 803, the combined prevention of obesity and DWCB would yield a net savings of $14 238 and a gain of 4.8 QALYs (a net savings of $2966 per QALY gained).

COMMENT

The first study of the economic effect of Planet Health found that an estimated $27 042 in medical costs and 4.1 QALYs would be saved by the program as a result of preventing and reducing obesity among adolescent girls.[17] In the current study, we found that an additional mean (range) savings of $33 999 ($17 570-$58 962) in medical costs and an additional mean (range) QALYs of 0.7 (0.2-1.3) would be gained by the program as a result of preventing DWCB. At an intervention cost of $46 803, the combined prevention of obesity and DWCB would yield a net savings of $14 238 and a gain of 4.8 QALYs. The findings indicate that the economic effect of Planet Health goes beyond obesity prevention. The intervention is not only more cost-effective than previously assessed but also generates net savings to society when the other cost savings (ie, loss of productivity costs) are not even considered.

Previous studies have attempted to assess the cost-effectiveness of specific treatment for BN.[24,35,41] To our knowledge, the present study is the first economic study of a primary prevention intervention of ED. Because of the small scale of the intervention (5 middle schools and 254 girls) and the relatively low prevalence of DWCB, we estimated that only 1 girl would be prevented from developing BN by age 17. However, if the program were implemented on a larger scale, for example in 100 schools of similar size to those in the original Planet Health RCT, we would expect approximately 26 cases of BN to be prevented, $680 001 in treatment costs saved, and 13.2 QALYs gained.

This study has several limitations. First, the number of cases of BN prevented was modeled rather than directly measured. Second, because of a lack of available information in the literature, an assumption of 50% was made about the percentage of girls with DWCB who had SED. We conducted sensitivity analyses to test this assumption. Third, only a single data source was available for the long-term medical cost estimate and the HRQL estimate. We addressed the uncertainty caused by the 2 parameter estimates by performing sensitivity analyses on the 2 parameters. Fourth, we did not include medical costs for the treatment of subdiagnostic BN or travel costs related to treatment of BN. However, including such costs can only make the intervention more cost-effective. Fifth, we assumed that the individuals who were prevented from getting SED would not go on to BN. According to current research, young women have less than a 1% chance to develop BN without any ED syndromes in the teenage years.[42,43]

Because of these limitations, we have been cautious in our approach and have carefully conducted sensitivity analyses. The results of these sensitivity analyses indicated that the projected benefits were dependent on the

accuracy of the 4 major parameter estimates: (1) progression probability from DWCB to BN, (2) percentage of girls with DWCB who have SED, (3) long-term medical costs for BN treatment, and (4) HRQL of people with BN. Future treatment trials for ED should consider inclusion of those variables in their study. Future intervention studies of primary prevention programs may consider inclusion of a diagnostic instrument in their survey to directly obtain an intervention's effect on SED.

CONCLUSION

In our study, we projected the health and economic benefits achieved with the Planet Health intervention by preventing DWCB. When combining the intervention's effect on both obesity prevention and DWCB prevention, the Planet Health program is more cost-effective and more cost-saving than previously assessed. Public health interventions in a cost-conscious environment must be not only effective but also cost-effective. The results of this study suggest that primary prevention programs, such as Planet Health, warrant careful consideration by policy makers and program planners. The findings of this study also provide additional argument for integrated prevention of obesity and ED.

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