




## Short Communication

# Economic evaluation of a farm-to-Special Supplemental Nutrition Programme for Women, Infants and Children intervention promoting vegetable consumption

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### Abstract

**Objective:** To evaluate the cost and cost-effectiveness of a farm-to-Special Supplemental Nutrition Programme for Women, Infants and Children (WIC) intervention to promote vegetable intake and the redemption of WIC vouchers for produce purchases at farmers' markets.

**Design:** An economic analysis was undertaken using data from a pilot of the intervention. Vegetable intake was assessed with a reflection spectroscopy device (the Veggie Meter<sup>®</sup> [VM]) and via self-report. Voucher redemption was reported by WIC. Total and per participant intervention costs and cost-effectiveness ratios (expressed as cost per intervention effect) were estimated in 2019 US dollars over a 6-month period from the perspective of the agency implementing the intervention.

**Setting:** A large, urban WIC agency.

**Participants:** Participants were 297 WIC-enrolled adults.

**Results:** Post-intervention, VM scores, self-reported vegetable intake and voucher redemption were higher in the intervention as compared with the control study group. Over the 6-month period, intervention costs were \$31 092 (\$194 unit cost per participant). Relative to the control group, the intervention cost \$8.10 per increased VM score per participant, \$3.85 per increased cup/d of vegetables consumed per participant and \$3.29 per increased percentage point in voucher redemption per participant.

**Conclusions:** Intervention costs and cost-effectiveness ratios compared favourably with those reported for other interventions targeting vegetable intake in low-income groups, suggesting that the programme may be cost effective in promoting vegetable purchases and consumption. As there is no benchmark against which to compare cost-effectiveness ratios expressed as cost per unit of effectiveness, conclusions regarding whether this is the case must await further research.

**Keywords**  
Farm-to-institution  
WIC programme  
Vegetable consumption  
Economic analysis

Despite well-established health benefits of fruit and vegetable consumption, increasing evidence recognises a distinction between fruits and vegetables in determinants, impacts on health and intake levels<sup>(1,2)</sup>. Increasing work also suggests health benefits from a high consumption specifically of vegetables, yet intakes remain low, and barriers to increasing consumption are prevalent making intervention difficult<sup>(1)</sup>. A systematic review of interventions to promote consumption of vegetables as a distinct food group found

that a variety of successful strategies have been tried<sup>(1)</sup>. However, long-term effects and cost-effectiveness were rarely considered, and certain groups, e.g. individuals of low socio-economic status, were noticeably absent<sup>(1)</sup>.

In a recent pilot of a farm-to-institution intervention for low-income adults served by the Special Supplemental Nutrition Programme for Women, Infants and Children (WIC), the investigators found post-intervention between-group differences in vegetable intake favouring participants who received the

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intervention relative to those who did not<sup>(3)</sup>. Receipt of the intervention was also associated with the redemption of Farmers' Market Nutrition Programme (FMNP) vouchers provided by WIC for produce purchases at farmers' markets. In this Short Communication, we estimate intervention costs and relate them to primary outcomes of vegetable intake and FMNP voucher redemption. Findings will inform decision makers in other WIC and maternal and child health agencies contemplating implementing the programme or a similar intervention and may serve as a reference for future research in this area<sup>(4)</sup>.

To determine whether an intervention is a good value for money, it is necessary to estimate and compare the ratio of intervention costs to effects<sup>(5)</sup>. To date, there have been few economic analyses of interventions to promote fruit and vegetable consumption relative to the many analyses of programmes targeting other lifestyle behaviours, e.g. physical activity and obesity<sup>(5)</sup>. Quality-adjusted life-years have been used extensively in cost-effectiveness analyses for quality of life outcomes<sup>(6)</sup>. This is natural because improved quality of life is one of the possible benefits of dietary interventions<sup>(6)</sup>. An advantage of quality-adjusted life-years is that they provide a common metric for estimating and comparing the outcomes of what are often heterogeneous interventions<sup>(7)</sup>. However, quality-adjusted life-years may not be consistent with the way decision makers value health interventions. For example, WIC administrators may favour programmes resulting in the largest between-group differences in dietary behaviours and FMNP voucher redemption, which is low in the WIC population (nationwide in 2019, 55 % of FMNP voucher recipients redeemed the vouchers)<sup>(8)</sup>. Thus, the performance of a programme expressed as cost/natural unit, for example, the cost per additional serving of vegetables consumed per person/d, may be more informative to such stakeholders regardless of their efficiency from a quality-adjusted life-year-optimising standpoint<sup>(9)</sup>. For this reason, we did not calculate cost-effectiveness ratios using quality-adjusted life-years or other such metrics as health care cost savings, but instead as cost per intervention effect.

## Methods

### *Setting, design and sample*

The research protocol is described elsewhere<sup>(3)</sup>. In brief, the intervention was piloted in three sites of an urban WIC agency located in New Jersey, USA (one randomised to the intervention study group and two to the control group) with 297 adults (160 enrolled at the intervention site and 137 at control sites)<sup>(3)</sup>. Intervention participants received routine WIC services, for example, vouchers for nutritious foods and nutrition and breast-feeding education and the intervention<sup>(10)</sup>. Control participants received routine services only. Data were collected via telephone and in person at baseline and at mid- and post-intervention (3 and 6 months post-baseline, respectively). This study was conducted according to the guidelines laid down in the

Declaration of Helsinki, and all procedures involving study participants were approved by the William Paterson University Institutional Review Board for Human Subject Research (2018-339). Verbal informed consent was obtained from participants completing telephone assessments and was formally recorded; written informed consent was obtained from those completing in-person assessments.

### *Intervention*

In preliminary work, we examined the feasibility and acceptability of the planned intervention<sup>(11)</sup>. Findings of this work informed revisions for finalising the programme. The intervention combined behaviourally focused instruction and handouts with the introduction of a WIC-based farmers' market, field trips to an area farmers' market, telephone coaching and support and recipe demonstrations and tastings, as summarised in Table 1.

### *Measures*

Vegetable intake was assessed objectively using a reflection spectroscopy device, the Veggie Meter<sup>®</sup> (Longevity Link Inc., Salt Lake City, UT), to assess dermal carotenoids as a biomarker of intake<sup>(12–14)</sup>. Scans of the fingertip were taken in triplicate and averaged (score range = 0–800; higher scores indicate higher carotenoid levels). Vegetable intake was also measured by self-report with the following item: 'How many cups of vegetables (including 100 % vegetable juice) do you eat or drink each day?'<sup>(15)</sup>. To facilitate the estimation of food portions, participants were told that a cup was about the size of their fist<sup>(16)</sup>. FMNP voucher redemption was objectively assessed using data provided by WIC. WIC reported whether participants redeemed any vouchers (yes/no) during the voucher redemption period (1 June, to 30 November 2019).

### *Intervention costs*

Direct intervention costs were categorised as fixed, variable or step variable costs. Whereas fixed costs include expenses to develop and implement an intervention regardless of the number of people who receive it, variable costs include expenditures tied directly to the number of recipients<sup>(17)</sup>. A portion of the variable costs, referred to as 'step variable costs,' arise from intervention activities that are performed in discrete units (e.g. with groups of participants)<sup>(18)</sup>. The method of calculating step variable costs was to estimate and assign the cost of an activity to a group of participants and to account for the number of times the activity was offered. Research costs to evaluate the intervention were excluded. FMNP vouchers were provided to participants through the WIC programme; consequently, there were no intervention costs for the vouchers<sup>(19)</sup>. Overhead costs associated with use of the WIC office, equipment and support services were estimated at a rate of 20 % of direct costs. Total costs (direct and overhead) were divided by the number of intervention participants (160) to obtain a unit cost per participant<sup>(20)</sup>. Total and per participant intervention costs were estimated over a 6-month period in 2019 US dollars from the perspective of the agency implementing the intervention.

**Table 1** Components of the farm-to-WIC intervention

Component	Implementation
WIC-based farmers' market	Monday through Saturday in summer 2019 during FMNP voucher issuance period
Field trips to area farmers' market	One trip per month in September, October and November (3 trips in total)
Recipe demonstrations and tastings	Demonstrations and tastings of three recipes each at the WIC-based market and area farmers' market (12 recipes in total)
Recipe packs	Packs provided to participants containing the ingredients for one of the recipes demonstrated at the WIC-based market and on each of 3 trips to the area farmers' market (4 packs in total)
Handouts	Packets provided to participants containing vegetable fact sheets (11 in total, each featuring a single vegetable with tips on how to select, store and prepare the item); recipe steps (12 in total, each depicting the steps (in words and images) for completing recipes demonstrated in the programme); vegetable seasonality chart; and map of the area farmers' market
Telephone coaching and support	20 min of coaching and support provided before and after field trips (4 calls in total)
Behaviorally focused nutrition education	
WIC-based market	
Group-based instruction	20 min of instruction provided to participants while waiting for WIC appointments during which they received FMNP vouchers
Individualised instruction	Up to 10 min of instruction per participant provided to those returning to the onsite market after WIC appointments
Monthly trips to area farmers' market	
Group-based instruction	20 min of instruction per trip
Individualised instruction	Up to 10 min per person provided to participants while shopping at the market

WIC, Special Supplemental Nutrition Programme for Women, Infants and Children; FMNP, Farmers' Market Nutrition Programme; FV, fruit and vegetable.

### Analysis

Between-group differences in vegetable intake and FMNP voucher redemption were examined with linear mixed-effects and logistic regression models adjusted for baseline measures and prognostic factors (potential influences on intake)<sup>(3)</sup>. When prognostic factors had a different distribution by study group at baseline, they were included as covariates in the analyses<sup>(3)</sup>. To quantify the magnitude of the differences, adjusted Cohen's *d* was calculated as the difference between least square means divided by the square root of the residual variance. In a synthesis of reviews and meta-analyses of interventions to promote fruit and vegetable intake in adults, between-group differences in intake at or above 0.30 were considered meaningful<sup>(21)</sup>. For FMNP voucher redemption, effect size was measured using the OR, where 1.5 is a small effect, 2.5 is a medium effect and 4 is a large effect<sup>(22)</sup>. Incremental cost-effectiveness ratios (ICER) were calculated as the total 6-month per-participant intervention cost divided by the post-intervention between-group difference in the outcome. For self-reported vegetable intake, the ICER was expressed as the cost per cup/d by dividing the total per participant cost in the ICER calculation by 180 (the number of intervention days). Analyses were conducted with SAS, version 9.4<sup>(23)</sup>. Statistical significance was set at  $P < 0.05$ .

### Results

#### Participant characteristics

Baseline characteristics of participants in the intervention group and the full sample are shown in Table 2. Most participants were Hispanic (73%), foreign-born (70%), reported a high school education or less (55%) and were overweight or obese (75%).

#### Intervention costs

As shown in Table 3, fixed development costs included personnel and participant incentives to pretest and finalise the intervention and translate materials to Spanish (total costs: \$6372). Training and supervision costs encompassed personnel (a trainer and trainees (four interventionists and their supervisor), and the supervisor's time overseeing the interventionists (total costs: \$2539). Fixed costs for the WIC-based market included supplies (e.g. tablecloths) and signage for point-of-sale messaging on display at the market. An area farmer provided produce for the market (deliveries were on Mondays, Wednesdays and Fridays), produce bags and bins to display foods, and the collaborating agency provided shelf space and refrigerators to store unsold items for the next market day and canvas bags for participants to carry their produce at no cost to the intervention. Total market costs were \$450. Costs for trips to the area farmers' market included bus service for 12 Saturday trips @ \$400/trip and supplies, e.g. trash bags (total costs: \$4820). For recipe demonstrations and tastings, costs were incurred for food ingredients and supplies (e.g. cooking equipment; total costs: \$937). Fixed costs for coaching and support calls encompassed supplies, e.g. file folders and forms (total costs: \$30). Total fixed costs were \$15 148.

Variable costs included interventionist time scheduling field trips and coaching and support calls. Relative to calls, additional time was required to schedule trips owing to the additional information discussed, e.g. details of the trip and what to set aside. Variable costs also included interventionist time providing 1:1 instruction at the WIC-based and area farmers' market, including coordination time between contacts. As coaching calls involved goal setting and progress monitoring, more time was needed for coordinating tasks, e.g. reviewing what was discussed on the previous call. Other variable costs included ingredients for recipe packs and photocopying of handouts. Total variable costs were \$12 960. Step variable

**Table 2** Selected baseline participant characteristics

Characteristic	Intervention group (n 160)		Full sample (n 297)	
	n	%	n	%
Age				
Mean	30.5		31.7	
SD	7.2		7.2	
Race, n (%)				
Did not identify a race	111	70	190	64
Black/African American	26	16	42	14
White or other*	23	14	65	22
Hispanic ethnicity, n (%)				
Non-Hispanic	45	28	80	27
Hispanic	115	72	217	73
Nativity, n (%)				
U.S.-born	52	32	88	30
Foreign-born	108	68	209	70
Language preference (foreign-born), n (%)				
English	24	22	46	22
Spanish	78	72	154	74
Other	6	6	9	4
CDC weight status category, n (%)†				
Underweight (< 18.5 kg/m <sup>2</sup> )	4	3	7	3
Normal weight (18.5 to < 25 kg/m <sup>2</sup> )	28	22	54	22
Overweight (25 to < 30 kg/m <sup>2</sup> )	44	34	88	36
Obese (≥ 30 kg/m <sup>2</sup> )	53	41	93	39
Educational attainment, n (%)				
Some high school or less	25	15	61	20
High school diploma or equivalent	57	36	103	35
More than high school	78	49	133	45

CDC, Centers for Disease Control and Prevention.

\*Includes nine participants reporting more than one race.

†As weight and height were measured at time of study entry, among pregnant participants, pre-pregnancy BMI could not be determined. Pregnant women (n 54) were therefore excluded from analyses of BMI.

costs included interventionist time conducting group-based instruction and recipe demonstrations and tastings plus set-up time (total: \$832). Overhead costs were \$2152. The overhead rate was not applied to the translation services, marketplace activities or use of the bus. Total intervention costs were \$31 092 (\$194 unit cost per participant).

### Intervention outcomes

Mid-intervention, Veggie Meter scores were higher in the control relative to the intervention group (mean (SE) = 269.98 (10.06) and 227.11 (9.91), respectively)<sup>(3)</sup>. Post-intervention, the scores were higher in the intervention relative to the control group (236.01 (9.77) and 212.10 (9.79), respectively)<sup>(3)</sup>. Self-reported vegetable intake did not differ by group at mid-intervention; post-intervention, it was higher in the intervention relative to the control group (1.83 (0.11) and 1.55 (0.12) cups/d, respectively)<sup>(3)</sup>. Adjusted rates of FMNP voucher redemption were 87% in the intervention group and 28% in the control group. Cohen's *d* was 0.35 for objectively measured intake and 0.34 for self-reported intake<sup>(3)</sup>. For FMNP voucher redemption, the adjusted OR was 17.39 (95% CI (8.64, 35.02)).

Based on adjusted post-intervention differences between intervention and control groups, ICER were \$8.10 for a 1-unit increase in Veggie Meter scores (\$194/24 units of study group difference), \$3.85 for a

1-cup/d increase in self-reported vegetable intake (((\$194/180 d)/0.28 cups/d of study group difference) and \$3.29 for a 1% increase in the FMNP voucher redemption rate (\$194/(87%–28%)). Lower ICER are generally indicative of greater cost-effectiveness<sup>(24)</sup>.

### Discussion

The study findings highlight the promise of a farm-to-WIC intervention for promoting vegetable purchases and consumption among urban, WIC-enrolled adults. Cohen's *d* for between-group differences in objective and self-reported vegetable intake (0.34–0.35) was meaningful<sup>(21)</sup>; for voucher redemption, the between-group difference of 59% and OR of 17.39 were large<sup>(22)</sup>.

Considering the novelty of the intervention, direct cost comparisons with other studies are difficult. However, an indirect comparison approach (with costs of other interventions adjusted to US dollars with reference year 2019 for comparability) may be useful<sup>(25)</sup>. The per participant intervention cost of \$194 was lower than that of an educational and skill-building intervention to promote vegetable intake among socio-economically disadvantaged women (\$275 per household in 2012 Australian dollars/\$294 in 2019 in US dollars where AU

**Table 3** Intervention costs

Cost	Description	Total for 160 participants
<b>Fixed costs</b>		
Intervention materials development		
Personnel		
Programme planner (PhD)	10 h @ \$100/h, total \$1000	1 programme planner to develop materials, total \$1000
Research assistant	24 h per research assistant to pretest materials @ \$15/h, total \$388	1 research assistant to pretest materials, total \$388
Supervisor	24 h per supervisor to oversee pretesting @ \$17/h, total \$439	1 supervisor to oversee pretesting
Translators	116 per translator @ \$17/h, total \$2123	1 translator each to forward-and back-translate materials, total \$4246
Participant incentives	\$10 per participant for 30 pretesting participants	Total \$300
Subtotal		\$6372
Training and supervision		
Personnel		
Trainees	4 h of training @ \$15/h per interventionist (total \$65) and \$17/h per supervisor (total \$73)	4 interventionists to deliver intervention and 1 supervisor to oversee interventionists, total \$333
Supervision	\$37 per interventionist per week (2 h/week @ \$17/h)	4 interventionists at the WIC-based market for 4 weeks and 2 interventionists for field trips and coaching and support calls for 16 weeks, total \$1776
Trainer	4 h per trainer (programme planner PhD) @ \$100/h, total \$400	1 trainer, total \$400
Training materials	\$6 per trainee	Materials for 4 interventionists and 1 supervisor, total \$30
Subtotal		\$2539
WIC-based market		
Produce	Provided by farmer as transfer (no intervention cost)	Total \$450
Supplies and signage		
Food storage and canvas bags	Provided by WIC agency at no intervention cost	
Subtotal		\$450
Field trips to area farmers' market		
Bus service	\$400 per trip	12 trips, total \$4800
Supplies		Total \$20
Subtotal		\$4820
Recipe demonstrations and tastings		
Food ingredients		Total \$185
Supplies		Total \$752
Subtotal		\$937
Telephone coaching and support		
Supplies		Total \$30
Subtotal		\$30
Total fixed costs		\$15 148
<b>Variable costs</b>		
Personnel		
Scheduling		
Field trips	\$12 per participant (3 trips at 15 min per trip @ \$15/h)	Total \$1920
Coaching and support calls	\$5 per participant (4 calls @ 5 min per call @ \$15/h)	Total \$800
1:1 instruction		
WIC-based market	\$4 per participant (10 min of instruction plus 5 min of coordination time @ \$15/h)	Total \$640
Field trips	\$12 per participant (3 trips @ 10 min per trip plus 5 min of coordination time @ \$15/h)	Total \$1920
Coaching and support calls	\$32 per participant (4 calls at 20 min per call plus 10 min of coordination time @ \$15/h)	Total \$5120
Recipe packs	\$12 per participant	Total \$1920
Handouts	\$4 per participant	Total \$640
Total variable costs	\$81 per participant	\$12 960
<b>Step variable costs</b>		
Personnel		
Group-based instruction		
WIC-based market	\$8 per group of 10 participants (20 min of instruction plus 10 min of set-up time @ \$15/h)	Total \$128

**Table 3** *Continued*

Cost	Description	Total for 160 participants
Field trips	\$8 per group of 10 participants (20 min of instruction plus 10 min of set-up time @ \$15/h) for 3 trips	Total \$384
Demonstrations/tastings	\$5 per group of 10 participants (15 min of demonstration/tasting plus 5 min of setup time @ \$15/h) for 4 sets of demonstrations	Total \$320
Total step variable costs		\$832
Total direct costs		\$28 940
<b>Overhead costs</b>		
Direct costs incurring overhead		\$10 760
Overhead	Use of WIC office, equipment, and support services (@ 20 % of direct costs)	\$2152
Total overhead costs		\$2152
<b>Total intervention costs</b>		\$31 092
<b>Unit cost per participant</b>		\$194

Hourly rates for part-time staff include fringe at a rate of .0765.

\$1 = US \$0.96, September 2012)<sup>(26)</sup>. In the educational and skill-building intervention, staffing costs were the largest cost, and staff were paid a higher hourly rate (\$41 in 2019 US dollars) than in this study, contributing to the higher cost<sup>(26)</sup>. The per participant cost was also lower than that of a price reduction intervention to promote vegetable purchases (\$316 per household in 2012 Australian dollars/\$338 in 2019 US dollars)<sup>(25)</sup>. The higher cost of the pricing intervention was likely due to the added expense to provide the pricing discounts. The per participant cost was also lower than the \$240/household cost in 2001 (\$346 in 2019 US dollars) for a 6-month voucher programme (\$10 voucher/week) to promote fruit and vegetable intake among WIC-enrolled women<sup>(27)</sup>. Although our programme was also designed to promote vegetable purchases, we leveraged an existing resource (FMNP vouchers) to do so; as such, there were no intervention costs to provide the vouchers.

There are no directly comparable ICER for Veggie Meter and voucher redemption data. For self-reported vegetable intake, the \$3.85 ICER was comparable with the cost per cups/d of vegetables consumed in the educational and skill-building intervention (\$6.24 in 2012 Australian dollars/\$6.67 in US dollars in 2019) and the US voucher programme (\$3.44 in 2019)<sup>(26,27)</sup>.

The WIC-based market was the least costly component to implement. Thus, in situations where resources are limited, WIC administrators may be able to introduce an onsite market at minimal cost. Cost savings may result from having WIC nutritionists deliver the intervention<sup>(28)</sup>.

The details of cost calculations presented in Table 3 allow programme planners to estimate costs to implement the programme with a different number of intervention participants than in this study. Fixed costs (other than costs to develop intervention materials and messages) would apply to implement the programme as is. If, however, existing content is adapted to meet the needs of local clientele (in terms of local culture and language) or new materials are added, costs to develop, translate and pretest the materials would be incurred. Possible additional fixed costs include physical

space and refrigerators to store unsold produce (unless a farmer agrees to deliver produce and pick up unsold items on the same day) and canvas carrying bags for participants. Variable costs also would apply. In non-WIC settings, programme planners considering providing participants with vouchers to purchase produce at farmers' markets would need to plan for this additional variable cost.

### **Limitations and strengths**

Although findings were comparable to studies of counseling and individual contact, comparisons should be interpreted with caution given differences in study designs and measures. The lack of information on comparable interventions limits the ability to make relative cost-effectiveness comparisons. The small number of study sites and single site in the intervention group limit the extent to which findings can be causally attributed to the intervention despite the randomised design<sup>(3)</sup>. Despite these limitations, findings add to the limited economic data on interventions to promote vegetable intake in low-income groups<sup>(1,29)</sup>. The objective measures of vegetable intake and FMNP voucher redemption are study strengths. The relatively new device for measuring dermal carotenoids is a novel feature of this study<sup>(3)</sup>.

### **Conclusion**

Costs and cost-effectiveness ratios for a farm-to-WIC intervention compared favourably with those for other interventions targeting vegetable intake in low-income groups<sup>(26,27)</sup>. Although these findings suggest that the programme may be cost effective in promoting vegetable purchases and consumption, the cost-effectiveness of the intervention could not be directly assessed as there is no threshold to compare and link ICER expressed as cost/natural unit to longer term health outcomes. Conclusions regarding whether this is in fact the case must therefore await further research<sup>(7)</sup>.

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