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Title:

Factors associated with the implementation of a vegetable and fruit program in a population of Australian elementary schools.

Authors:

Nathan N^{*1,2,3,4}, Wiggers J^{1,2,3,4}, Wyse R^{1,2,3,4}, Williams C.M^{1,2,3,4}, Sutherland R^{1,2,3,4}, Yoong SL^{1,2,3,4}, Lecathelinais C¹, Wolfenden L^{1,2,3,4}

1. Hunter New England Population Health, Hunter New England Area Health Service, Newcastle; Locked Bag No. 10 Wallsend NSW 2287 Australia
2. School of Medicine and Public Health, The University of Newcastle, Newcastle NSW 2308, Australia
3. Priority Research Centre for Health Behaviour, The University of Newcastle, Newcastle NSW 2308, Australia
4. Hunter Medical Research Institute, Newcastle NSW 2300, Australia

Running title:

Implementation of a vegetable and fruit program

Corresponding author

Nicole Nathan, Program Manager, Hunter New England Population Health Locked Bag No. 10, Wallsend NSW 2287, AUSTRALIA. Tel: +61 2 49246 257 Fax: +61 2 4924 6209 Email: Nicole.Nathan@hnehealth.nsw.gov.au

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ABSTRACT

Implementation of vegetable and fruit programs in schools is less than optimal. This study aimed to identify, using a theoretical framework, factors associated with implementation of a school vegetable and fruit program; that provides a time in class for children to consume a piece of vegetable or fruit they have brought from home. Three hundred and three randomly selected school principals across the state of New South Wales, Australia responded to a 25-minute telephone survey. Principals were asked if their school had implemented a vegetable and fruit program, and which of 12 factors from Damschroder's Consolidated Framework for Implementation Research had facilitated or impeded implementation. Multiple logistic regression models examined the association between such factors and program implementation. Seventy-eight per cent of schools had a vegetable and fruit program. Schools were significantly more likely to implement the program if the principal believed that: the program was effective (OR 2.97; $p < 0.02$); they had sufficient resources to implement the program (OR=4.22; $p < 0.0001$); the program would not be difficult to implement (OR=10.16; $p < 0.0001$); and that the program was as important as other school priorities (OR=2.45; $p < 0.02$). Realising the intended benefits of vegetable and fruit programs requires widespread implementation by schools. Consideration of principal beliefs about the program effectiveness, resources, difficulty and relative importance in program implementation strategies appear key to increasing program implementation.

INTRODUCTION.

Internationally, most children fail to consume adequate quantities of vegetables and fruit [1]. For example studies in the United States [2], United Kingdom [3] and Australia [4] have found that between 70-80% of children aged 5-18 years do not eat the recommended serves of vegetables (that is between 2½-5 serves) or fruit (that is between 1-2 serves). Adequate childhood consumption of vegetables and fruit is essential for healthy growth and development [5] and is hypothesized to protect against infections [6] and respiratory illnesses [7]. Furthermore, dietary habits established in childhood track into adulthood [8] reducing the risk of future obesity and chronic disease [1]. Accordingly, the implementation of population-based initiatives such as supportive environments, policies or programmes that increase vegetable and fruit intake by children is a recognised public health priority [9].

Schools represent an appropriate setting to increase children's intake of vegetables and fruit as they provide almost universal access to children over an extended period of time [10], and are recommended settings to address the health and well-being of children [11]. Interventions in this setting have been found to modestly improve student consumption of vegetables and fruit [1]. While school-based vegetable and fruit initiatives have been conducted in a number of countries including the United States [12], United Kingdom [13], Norway [14], New Zealand [15], where governments have provided free or subsidised vegetables and fruit to children, and Australia [16], where children are encouraged to bring vegetables and fruit from home to consume in class, implementation of such initiatives by schools is less than optimal, and has been suggested in some studies to vary according to school size, rurality and level of disadvantage [17]. For example, after more than a decade only 57% of eligible Norwegian elementary schools are reportedly registered for the subsidised fruit scheme [14], and with only 30% of children participating in the scheme [18]. In 2010 a representative random

sample of over 600 elementary schools in the United States found that only 25% of public elementary schools were participating in a program that provided reimbursement to lower socio-economic schools offering fresh vegetables and fruit to students during the school day [12]. Similarly, a 2010 study found that only 40% of Australian elementary schools were implementing, to the recommended level (that is in at least 80% of classes every school day), a government endorsed program that promoted children's consumption of a piece of vegetable or fruit, that they have brought from home, during class time [17].

For the potential public health benefits of school vegetable and fruit programs to be realised, implementation across the population of schools is necessary. Theoretical frameworks suggest that there is a need to consider a range of factors that may support or impede the implementation of programs in community settings if program implementation is to be maximised [19]. The Consolidated Framework for Implementation Research (CFIR) developed by Damschroder et al [20] is one such framework which provides a comprehensive taxonomy of constructs from multiple disciplines including psychology and organizational change that have been reported to influence program implementation. The CFIR constructs identifies 37 constructs, grouped into five domains which include: intervention characteristics (e.g. cost, perceived complexity, ease of implementation); outer setting factors (e.g. external policies, and peer behaviour), inner setting factors (e.g. alignment with organisational values, and access to information and support); characteristics of the individuals involved (e.g. their knowledge, attitudes and self-efficacy); and the process of implementation (e.g. planning).

A limited number of primary research studies have comprehensively evaluated the factors associated with schools' implementation of vegetable and fruit programs. One study of a vegetable and fruit intervention implemented in Danish secondary schools [21] found that

those schools that had a food policy and that had teachers and students who valued the program had higher rates of implementation than those without such characteristics. Conversely, a study within Australian elementary schools found no association between a school having a written school policy and implementation of a vegetable and fruit program [17]. However, the study found a significant association between program implementation and having teachers trained in delivery of the program. The CATCH Eat Smart School Nutrition Program conducted in The United States, that sought to improve the preparation, production and promotion of elementary schools food service through the implementation of East Smart guidelines, found that the percentage of guidelines implemented was not associated with the number of training sessions school food service staff had attended, but was associated with their perceived utility and satisfaction with program guidelines [22]. Furthermore, other studies have identified that the uptake of school vegetable and fruit programs is associated with other school characteristics, such as number of students and socio-economic and geographic characteristics. For example the 2015 study by Aarestrup et al [21] which examined the implementation of the Boost trial in 20 Danish schools, found that smaller schools, with fewer families of lower socio-economic background were more likely to consistently deliver the intervention at a high level. Similarly, the 2011 study by Nathan et al [17], which surveyed 384 Australian elementary school principals found that small schools, rural schools and schools from lower socio-economic areas were more likely to implement the recommended vegetable and fruit program. Despite providing an indication of the association between some school characteristics and school implementation of vegetable and fruit programs, no single study has reported on such associations across a broad range of characteristics. In the absence of such information it limits the development of interventions to maximise school implementation of such programs and subsequently our understanding of how successful interventions achieve their impact.

To address this evidence gap, a study was undertaken to determine the factors associated with the implementation of a vegetable and fruit program in Australian schools, using a comprehensive implementation theoretical framework. The study further sought to identify if school characteristics such as size, rurality and level of disadvantage was associated with these factors.

Policy context

In 2005, the Australian Government recommended all elementary schools provide a time in class for children to consume a piece of vegetable or fruit that they have brought from home. A program, *Crunch&Sip*® was made available to facilitate the implementation of such a vegetable and fruit break [16]. *Crunch&Sip*® encouraged schools to develop a school policy regarding the implementation of a vegetable and fruit break in class time; the implementation of such breaks; teaching and learning materials to reinforce related nutrition messages; and promotion of the program to teachers, students and parents. Since 2007 the New South Wales state government encouraged school implementation of *Crunch&Sip*® and offered, through a nongovernment organization [24] access to information-based support via a website and newsletters [23]. In 2010, the state government established the Healthy Children's initiative, to support schools to implement policies and programs to promote both healthy eating and physical activity, *Crunch&Sip*® being one of these programs, and developed formal implementation performance targets and monitoring systems for each [24].

METHODS

Ethical approval

Approval to conduct this study was obtained from Hunter New England (HNE) Local Health District Human Research Ethics Committee (no. 06/07/26/4.04), and relevant school ethics committees.

Design and setting

A cross sectional survey of elementary schools was conducted across the state of New South Wales (NSW), Australia. NSW has a population of approximately 863,000 children aged between 5 and 14 years and over 2200 elementary and central schools [25].

Participants and recruitment

A database of all NSW Government and non-Government (Catholic and Independent) elementary schools (that is those that cater for children aged five to twelve years of age) and central schools (that is those that cater for children aged five to eighteen years of age) (hereafter referred to as ‘elementary schools’) was generated from school lists provided on the websites of the Department of Education, the Catholic Education Commission and the Association of Independent schools. Special purpose schools (such as juvenile justice schools, hospital schools or school serving students with special needs) were excluded. From this database, a representative random sample of 476 (approximately 20%) eligible schools, stratified by school type and location, was drawn. Principals of schools within the sample were sent an information letter inviting them to participate in the study. Two weeks following mailing of the invitation, principals were telephoned by a trained research assistant, who confirmed school eligibility and sought participant consent.

Data collection

A 25-min Computer-Assisted Telephone Interview was conducted with consenting principals or their nominated delegate (hereafter referred to as principals). The survey was conducted from March to August 2014. Principals from central schools were asked to report on activities relevant to elementary school age classes (5–12 years) only.

Measures

Principals were asked a range of questions regarding the characteristics of their school and to assess the level of implementation of the vegetable and fruit program in their school and the factors associated with implementation of the vegetable and fruit program. Specifically this included;

School and principal characteristics

During the telephone interview, principals were asked to report the number of students attending the school and to provide some demographic data including their role in the school, how long they have been in that role and their years of teaching experience. School type (Government, non-Government Catholic or non-Government Independent) and the postcode of the locality of the school were obtained from school websites.

School implementation of a vegetable and fruit program

Implementation of a vegetable and fruit break in class time was used as the measure of program implementation. Using a validated measure [26], principals were asked to report if their school had implemented specific breaks to allow children to eat vegetables or fruit during class time ('yes - all classes', 'yes - some classes', 'no classes', 'don't know'). Principals who reported that 'yes - some classes' at their school had a vegetable and fruit break were then asked to estimate the percentage of classes that had such breaks. Principals

were also asked to indicate the number of days per week such breaks were usually implemented. Consistent with criteria indicated in the *Crunch&Sip*® program [27], schools were classified as implementing the vegetable and fruit program if they indicated having a vegetable and fruit break in at least 80% of classes every school day.

Factors associated with school implementation of the Crunch&Sip® program

To identify the factors associated with implementation of a vegetable and fruit program, survey items were developed based upon the Consolidated Framework for Implementation Research (CFIR) by Damschroder et al [20]. The CFIR recommends that only constructs relevant to the study context, intervention and setting be used [20]. For the current study, twelve survey items were developed to measure the constructs that could either promote or impede the implementation of a vegetable and fruit program (Table 2). All principals were read a description of the *Crunch&Sip*® program and, consistent with scales used to assess the significance of a CFIR domain on implementation, asked the extent to which they agreed with each of the 12 statements regarding its implementation in their school (on a 5-point Likert scale strongly agree - strongly disagree) (Table 2).

Analyses

All analyses were conducted using the statistical package SAS Version 9.2 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were used to describe school and principal characteristics. Schools were dichotomised based on school type: Government or non-Government (Catholic and Independent) schools. The reported number of enrolled students in each school was used to categorise schools as: ‘small schools’ (1–159 students); ‘medium schools’ (160–450 students) or ‘large schools’ (451+ students). School postcodes were also used to categorise the school’s locality as either ‘rural’ (those schools in outer regional,

remote and very remote areas) or ‘urban’ (those in regional cities and inner regional areas) based upon the Accessibility/Remoteness Index of Australia (ARIA) [28]. Schools with postcodes ranked in the top 50% of NSW postcodes based on the Socio-Economic Indexes For Areas (SEIFA) [29] Index of Relative Socio-economic were categorised as schools in ‘higher socio-economic areas’, while those in the lower 50% were categorized as schools in ‘lower socio-economic areas’.

Whilst the use of the 5-point likert scale was intended to assess the significance of a CFIR domain on implementation, for ease of interpretation of logistic regression results responses to the items regarding principal agreement with each of the implementation factors were collapsed into two groups; “Agree” (strongly agree, agree) and “Disagree” (neutral, disagree, strongly disagree). Three survey items were reverse coded (i.e. phrased in the semantically opposite direction). For the purposes of analysis and interpretation, these were converted to the same format as the other questions, where agreement with the statement was considered to facilitate implementation. Separate logistic regression analyses were initially performed to examine univariate associations between each of the 12 implementation factors (independent variables) and principal report of whether the school had implemented a vegetable and fruit break (dependent variable), with schools not having implemented such a break being the reference group. Implementation factors that were shown to be associated in such analyses ($p\text{-value} < 0.25$) were subsequently included in a backwards multiple logistic regression model to examine which implementation factors were independently associated with school implementation of a vegetable and fruit break, controlling for school characteristics (school size, rurality or level of disadvantage). An interaction term was included for each implementation factor and each school characteristic.

RESULTS

Sample and school characteristics

Of the 476 schools invited to participate in the survey, 17 could not be contacted (3.6%), 156 refused to participate (32.7%), and 303 (63.7%) participated in the survey. Characteristics of participating schools are shown in Table 1. Of the survey participants, most (76%) were Principals, with 6% Acting Principals and 6% Deputy or Assistant Principals, with an average of 299 months (SD = 114 months) teaching experience, and an average of 54 months (SD = 54 months) experience in their current role. Survey participants were significantly more likely than non-participants to come from Government schools (79% vs 63%, $p<0.01$), rural schools (31% vs 16%, $p<0.01$) and schools in lower socio-economic areas (66% vs 50%, $p<0.01$).

INSERT TABLE 1 HERE

School implementation of a vegetable and fruit break

Seventy-eight percent of schools reported that they were implementing a vegetable and fruit break on 5 days per week in at least 80% of classes.

Factors associated with school implementation of vegetable and fruit break.

Univariate regression analyses found that all implementation factors were associated with the implementation of a vegetable and fruit break (Table 2). The multiple logistic regression analysis showed that, four of the twelve-implementation factors were significantly associated with the implementation of a vegetable and fruit program (Table 2). Principals who agreed that: there is evidence that the Crunch&Sip® program increases student consumption of

vegetables and fruit (OR=2.97; 95% CI 1.27- 6.97; $p= 0.0121$); their school had sufficient resources to implement the Crunch&Sip® program (e.g. money, time) (OR=4.22; 95% CI 1.81- 9.85; $p=0.0009$) were significantly more likely to have implemented a vegetable and fruit break. Principals who agreed that the Crunch&Sip® program would be difficult for schools to implement (OR=10.16; 95% CI 4.38- 23.54; $p<.0001$), or who agreed that implementing the Crunch&Sip® program is far less important than other priorities within the school (OR=2.45; 95% CI 1.21- 4.95; $p=0.0129$) were significantly less likely to be implementing a vegetable and fruit program. No significant interactions ($p< 0 .01$) were found between implementation factors and school characteristics (size, rurality, or level of disadvantage).

INSERT TABLE 2 HERE

DISCUSSION

Using the Consolidated Framework for Implementation Research (CFIR) this study sought to identify the independent associations between a range of constructs and schools' implementation of a vegetable and fruit program in Australian elementary schools. Independent associations were observed between the implementation of the vegetable and fruit program and four implementation factors: strength of evidence; complexity; relative priority and available resources. The observed associations did not differ according to school size, rurality or level of disadvantage.

No previous studies have used a theoretical framework to comprehensively examine the association between a range of theoretically determined implementation factors and schools' implementation of a vegetable and fruit program. Nonetheless, the findings of this study are

consistent with other studies of school nutrition programs, which have highlighted the importance of minimising program complexity [30, 31]. The CFIR suggests that the perceived “complexity” of an initiative, which includes; the range and number of tasks, the time to do the tasks and the degree to which the task is a departure from routine practice contributes to the likelihood of implementation. Given schools routinely report a “crowded curriculum” as a barrier to implementing health promotion programs [17], developing an intervention that is simple, well-defined and that can be embedded into routine school practice is recommended in order to facilitate implementation in this setting.

However, unlike other studies [32-34], which suggest program costs and adaptability are important factors for consideration when implementing school nutrition programs these factors were not identified as significant factors influencing program implementation in this study. Furthermore, these findings are not consistent with a study of 215 Australian childcare managers which, using the CFIR, found that readily available external support was significantly associated with implementation of healthy eating and physical activity policies and practices in early childcare services. The inconsistency of the findings across studies may reflect differing jurisdictional, setting or program contextual issues, which have been suggested to influence program implementation [35].

The findings that the implementation of the vegetable and fruit break was associated with principal’s perception that the program is evidence based and relevant to the school priorities highlights the importance of communicating the benefits and relevance of school vegetable and fruit programs to school principals and staff. According to the CFIR stakeholders’ opinion of the quality or validity of the strength of evidence can be influenced by published literature, data from pilot studies and anecdotal stories from colleagues. Using relevant school

education departments or opinion leaders [26, 34] or training [22] may represent strategies for addressing these determinants. Engagement of school staff during program development is suggested to be particularly important in ensuring that a program is aligned with school priorities [34]. Previous research suggests that such engagement with end-users is not widespread in the development and reporting of child obesity prevention programs generally [36] thereby limiting the intended benefits of programs for children.

This study found principal's reported commitment of school resources was associated with program implementation. As inadequate resources are commonly reported as a barrier to school implementation of health promotion initiatives [37], strategies to secure principals' commitment of time, resources or personnel may need to be considered during initial engagement discussions with schools. Memorandums of understandings or integration of programs into school management plans have been used successfully in previous trials [26] to ensure school commitments and support implementation of vegetable and fruit breaks.

The study findings should be considered in light of its design characteristics. First, a strength of the study is the use of a large representative sample of schools drawn from the population of all schools in the state, enhancing the generalisability of its findings. However, the extent to which the findings are applicable to other jurisdictions is unknown. Second, the study used a self-report measure of vegetable and fruit breaks in schools, and of the extent of implementation of such breaks. It is considered the inherent inaccuracy of self-report measurement was limited by the use of a validated measure of vegetable and fruit programs in this study [26]. Third, given single items were used to assess the CFIR constructs the psychometric properties of the tool used in the study are unknown, therefore future studies should aim to validate these measures. Finally given the cross-sectional nature of the study

these findings may only be considered associations, and thus future prospective intervention studies are warranted to determine if strategies to address the four factors associated with the implementation of a vegetable and fruit break identified in this study are effective in increasing the likelihood of schools' implementation of vegetable and fruit breaks.

Despite these limitations, the study provides an important contribution to the field of implementation science, as it provides policy makers and practitioners with practical information to use in the design of interventions to support schools' implementation of vegetable and fruit programs. Future research examining how interventions impact on these constructs for example through mediation analyses would represent a considerable opportunity for implementation scientists to better understand intervention mechanisms.

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370 **CONFLICT OF INTEREST**

371 The authors declared no potential conflicts of interest with respect to the research, authorship,
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375 REFERENCES

- 376 1. Evans, C.E., et al., *Systematic review and meta-analysis of school-based interventions*
377 *to improve daily fruit and vegetable intake in children aged 5 to 12 y.* American
378 Journal of Clinical Nutrition, 2012. **96**: p. 889–901.
- 379 2. Centres for Disease Control and Prevention. *Children eating more fruit, but fruit and*
380 *vegetable intake still too low.* 2014 24th August 2015]; Available from:
381 <http://www.cdc.gov/media/releases/2014/p0805-fruits-vegetables.html>.
- 382 3. The NHS Information Centre and Lifestyles Statistics, *Statistics on obesity, physical*
383 *activity and diet: England, 2013* The Health and Social Care Information Centre,
384 Editor. 2014.
- 385 4. Australian Bureau of Statistics. *43640DO013_20112012 Australian Health Survey:*
386 *First Results, 2011–12 — Australia.* 2012 22nd November 2015]; Available from:
387 [http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0012011-](http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0012011-12?OpenDocument)
388 [12?OpenDocument](http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0012011-12?OpenDocument).
- 389 5. National Health and Medical Research Council, *Australian Dietary Guidelines,*
390 National Health and Medical Research Council, Editor. 2013, Australian Government:
391 Canberra.
- 392 6. Slavin, J.L. and B. Lloyd, *Health Benefits of Fruits and Vegetables.* Advances in
393 Nutrition: An International Review Journal, 2012. **3**(4): p. 506-516.
- 394 7. Seyedrezazadeh, E., et al., *Fruit and vegetable intake and risk of wheezing and*
395 *asthma: a systematic review and meta-analysis.* Nutrition Reviews, 2014. **72**(7): p.
396 411-428.
- 397 8. Kaikkonen, J.E., et al., *Does childhood nutrition influence adult cardiovascular*
398 *disease risk?--insights from the Young Finns Study.* Ann Med, 2013. **45**(2): p. 120-8.
- 399 9. World Health Organisation, *Population-based approaches to childhood obesity*
400 *prevention.* 2012: Geneva, Switzerland.
- 401 10. Carter, M. and B. Swinburn, *Measuring the 'obesogenic' food environment in New*
402 *Zealand primary schools.* Health Promotion International 2004. **19**(1): p. 15-20.
- 403 11. World Health Organisation, *School Policy Framework: Implementation of the WHO*
404 *Global Strategy on Diet, Physical Activity and Health,* in *WHO Library Cataloguing-*
405 *in-Publication Data.* 2008, World Health Organisation: Geneva, Switzerland. p. 1-48.
- 406 12. Ohri-Vachaspati, P., L. Turner, and F.J. Chaloupka, *Fresh Fruit and Vegetable*
407 *Program Participation in Elementary Schools in the United States and Availability of*
408 *Fruits and Vegetables in School Lunch Meals.* Journal of the Academy Of Nutrition
409 And Dietetics, 2012. **112**(6): p. 921-926.
- 410 13. Teeman, D., et al., *The third evaluation of the school fruit and vegetable scheme.*
411 2010, National Foundation for Educational Research & University of Leeds.
- 412 14. Bere, E., M.B. Veierbd, and K.-I. Klepp, *The Norwegian School Fruit Programme:*
413 *evaluating paid vs. no-cost subscriptions.* Preventive Medicine 2005. **41** p. 463-470.
- 414 15. Boyd, S., et al., *Taking a bite of the apple: The implementation of Fruit in Schools*
415 *(Healthy Futures evaluation report to the Ministry of Health)* 2007, New Zealand
416 Council for Educational Research: Wellington.
- 417 16. NSW Ministry of Health. *Crunch&Sip.* 2015 [cited 2015 28th August]; Available
418 from: <http://www.healthykids.nsw.gov.au/campaigns-programs/crunch-sip.aspx>.
- 419 17. Nathan, N., et al., *Vegetable and Fruit Breaks in Australian Primary Schools:*
420 *prevalence, attitudes, barriers and implementation strategies.* Health Education
421 Research, 2011. **76**: p. 722-731.

18. Øvrum, A. and E. Bere, *Evaluating free school fruit: results from a natural experiment in Norway with representative data*. Public Health Nutrition, 2013. **17**(6): p. 1224–1231.
19. Nilsen, P., *Making sense of implementation theories, models and frameworks*. Implement Sci, 2015. **10**: p. 53.
20. Damschroder, L.J., et al., *Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science*. Implementation Science, 2009. **4**(1): p. 50.
21. Aarestrup, A.K., et al., *Implementation of strategies to increase adolescents' access to fruit and vegetables at school: process evaluation findings from the Boost study*. BMC Public Health, 2015. **15**(86).
22. Mccullum-Gomez, C., et al., *Factors Influencing Implementation of the Coordinated Approach to Child Health (CATCH) Eat Smart School Nutrition Program in Texas*. Journal of the American Dietetic Association, 2006. **106**: p. 2039-2044.
23. Wiggers J, et al., *Good for Kids, Good for Life 2006-2010 Evaluation Report.*, NSW Ministry of Health, Editor. 2013, NSW Ministry of Health: Sydney.
24. Farrell L, et al., *Applying a performance monitoring framework to increase reach and adoption of children's healthy eating and physical activity programs.* . Public Health Research & Practice, 2014. **25**(1).
25. Australian Bureau of Statistics (ABS), *Australian Demographic Statistics, Population Estimates by Age and Sex, New South Wales by Geographical Classification, cat. no 3235.0*, ABS, Editor. 2009: Canberra.
26. Nathan, N., et al., *Effectiveness of a multi-strategy intervention in increasing the implementation of vegetable and fruit breaks by Australian primary schools: a non-randomised controlled trial*. BMC Public Health, 2012. **12**(651).
27. Government of Western Australia Department of Health. *Crunch&Sip®*. 2015 [25th July 2015]; Available from: <http://www.crunchandsip.com.au/what-is-crunchsip/>.
28. Australian Bureau of Statistics (ABS), *Statistical Geography Volume 1- Australian Standard Geographical Classification (ASGC). Cat. no 1216.0*. 2006, Commonwealth of Australia: Canberra.
29. Australian Bureau of Statistics (ABS), *Technical Paper: Census of Population and Housing: Socio-Economic Indexes For Australia (SEIFA). Cat. no 2039.0.55.001* 2001, Commonwealth of Australia: Canberra.
30. Nanney, M.S., et al., *Awareness and adoption of a nationally disseminated dietary curriculum*. Am J Health Behav, 2007. **31**(1): p. 64-73.
31. Bounds, W., M.F. Nettles, and J.T. Johnson, *Recess Before Lunch Programs in Elementary Schools: Perceptions and Practices of School Professionals*. The Journal of Child Nutrition and Management, 2009. **33**(1).
32. Levine, E., et al., *The Team Nutrition Pilot Study: Lessons Learned from Implementing a Comprehensive School-Based Intervention*. Journal of Nutrition Education and Behaviour, 2002. **34**(2): p. 109-116.
33. Hoelscher, D., et al., *Dissemination and adoption of the Child and Adolescent Trial for Cardiovascular Health (CATCH): a case study in Texas*. Journal of Public Health Management and Practice, 2001. **7**(2): p. 90-100.
34. Franks, A.L., et al., *School-based Programs: Lessons Learned from CATCH, Planet Health, and Not-On-Tobacco*. Preventing Chronic Disease: Public Health Research, Practice and Policy, 2007. **4**(2).
35. Glasgow, R.E. and D. Chambers, *Developing robust, sustainable, implementation systems using rigorous, rapid and relevant science*. Clin Transl Sci, 2012. **5**(1): p. 48-55.

- 472 36. Wolfenden L, et al., *How useful are systematic reviews of child obesity interventions.*
473 *Obesity Reviews*, 2010. **11**: p. 159-165.
- 474 37. Lister-Sharp, D., et al., *Health promoting schools and health promotion in schools:*
475 *two systematic reviews.* *Health Technology Assessment*, 1999. **3**(22): p. 1-207.
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Table 1: Participating School Characteristics

Characteristics of participating schools	N	%
All schools	303	
School type^a		
Government	239	79
Non-Government	64	21
School size^b		
Small	123	41
Medium	127	42
Large	52	17
ARIA^c		
Rural	93	31
Urban	210	69
SEIFA^d		
Low	201	66
High	102	34

^aSchool type (non-Government)= Catholic and Independent schools.

^bsmall schools=1–159 students; medium schools= 160–450 students; large schools= 451+ students.

^cARIA= Accessibility/Remoteness Index of Australia

^dSEIFA= Socio-Economic Indexes For Areas (SEIFA)

Table 2: Association between implementation factors and school implementation of a vegetable and fruit program.

CFIR Domain :	CFIR Construct	Survey Item: Implementation Factor	Response Category [#]	Implementing VF break (Daily in 80% of classrooms n=235 (%))	Univariate Analysis: Unadjusted OR [95% CI]	p-value	Multivariate analysis: Adjusted OR [95% CI]	p-value
Characteristics of the intervention	Evidence strength & quality	There is convincing evidence that the <i>Crunch&Sip</i> ® program increases student consumption of vegetables and fruit.	Agree	219 (93)	7.96 (3.92-16.14)	<.0001	2.97 (1.27-6.97)	0.0121
			Disagree	16 (7)	1.0		1.0	
	Adaptability	The <i>Crunch&Sip</i> ® program can be easily adapted to fit in with schools routines.	Agree	223 (95)	12.24 (5.74-26.10)	<.0001		
			Disagree	12 (5)	1.0			
	Complexity	The <i>Crunch&Sip</i> ® program would be difficult for schools to implement.	Agree	14 (6)	1.0	<.0001	1.0	<.0001*
			Disagree	221 (94)	12.46 (6.06- 25.65)		10.16 (4.38- 23.54)	
	Cost	Implementing the <i>Crunch&Sip</i> ® program would be costly for schools.	Agree	36 (15)	1.0	<.0001		
			Disagree	199 (85)	4.91 (2.71-8.90)			

CFIR Domain :	CFIR Construct	Survey Item: Implementation Factor	Response Category [#]	Implementing VF break (Daily in 80% of classrooms n=235 (%))	Univariate Analysis: Unadjusted OR [95% CI]	p-value	Multivariate analysis: Adjusted OR [95% CI]	p-value
Outer Setting	External Policies	My education department recommends that schools implement the <i>Crunch&Sip</i> ® program.	Agree	153 (65)	2.83 (1.63-4.94)	0.0002		
			Disagree	82 (35)	1.0			
Inner Setting	Compatibility	The <i>Crunch&Sip</i> ® program is consistent with the philosophy and ethos of our school.	Agree	224 (95)	6.79 (3.00-15.36)	<.0001		
			Disagree	11 (5)	1.0			
	Relative priority	Relative to other priorities in my schools, implementing the <i>Crunch&Sip</i> ® program is far less important.	Agree	82 (35)	1.0	<.0001	1.0	0.0129*
			Disagree	153 (65)	4.79 (2.49-8.05)		2.45 (1.21- 4.95)	
	Organisational incentives & Rewards	Implementing the <i>Crunch&Sip</i> ® program enhances the reputation of a school	Agree	159 (68)	3.84(2.17-6.77)	<.0001		
			Disagree	76 (32)	1.0			
	Available	My School has dedicated	Agree	125 (53)	7.45	<.0001	4.22 (1.81- 9.85)	0.0009*

CFIR Domain :	CFIR Construct	Survey Item: Implementation Factor	Response Category [#]	Implementing VF break (Daily in 80% of classrooms n=235 (%))	Univariate Analysis: Unadjusted OR [95% CI]	p-value	Multivariate analysis: Adjusted OR [95% CI]	p-value
	Resources	substantial resources (e.g. money, time) to implement the <i>Crunch&Sip</i> ® program.			(3.53-15.72)			
			Disagree	110 (47)	1.0		1.0	
	Access to information & knowledge	External support is readily available to help schools implement the <i>Crunch&Sip</i> ® program.	Agree	157 (67)	3.94 (2.23-6.97)	<.0001		
			Disagree	78 (33)	1.0			
Individuals	Knowledge and beliefs about the intervention	I believe it is important to implement the <i>Crunch&Sip</i> ® program	Agree	219 (93)	10.18(5.06- 20.48)	<.0001		
			Disagree	16 (7)	1.0			
Process	Planning	The <i>Crunch&Sip</i> ® program is included within our school management plan.	Agree	88 (37)	7.54(2.92-19.47)	<.0001		
			Disagree	147 (63)	1.0			

[#] Agree consists of those reporting agree and strongly disagree; *p significant ≤ 0.05