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Translating advice to eat more vegetables into practice: observations from a 12-month weight loss trial

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Abstract

Objectives: This study aimed to identify the main vegetable sources of overweight participants during a 12-month randomised controlled trial for weight loss.

Methods: Secondary analysis using data from diet history interviews to determine changes to daily vegetable intake amounts and types throughout the trial at 0, 3 and 12 months.

Results: Pre-trial 77% participants consumed frozen vegetables. At baseline (n = 113, 85 F), participants reported 345 ± 170 (56-920) g/day vegetables increasing to 498 ± 180 (146-930) g/day at 3 months and remaining stable at 475 ± 169(170-1053) g/day by 12 months (p = 0.001). At baseline, 32 of 34 different vegetable categories were reported, mainly tomato (69.9 g/day) and, potato (58.2 g/day). After 3 months (n = 109), seven vegetables remained in the top 10 reported (contributing 72%). Tomato remained top ranked to 12 months.

Conclusion: Following advice to consume more vegetables, consumption increased above the Australian Dietary recommendation of ~375 g/day. Tomatoes remained a mainstay regardless of the time of year, but choices changed with time. Frozen vegetables may be a feasible option.

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Translating advice to eat more vegetables into practice: Observations from a 12 month weight loss trial

Running title: Translating vegetable advice into practice

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ABSTRACT

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VEGETABLE INTAKES IN CLINICAL TRIALS

Advice for weight management suggests a wide variety of low-fat and nutrient-dense foods. Such messages translate to increased vegetable intakes with a positive association for weight change with higher fibre vegetable types.[1, 2] Despite dietary guidelines there is a perceived difficulty to increase the amount eaten.[3] The aim of this study was to describe the pattern of vegetable consumption of participants in a weight loss trial.

A secondary observational analysis of a 12 month parallel, randomised controlled trial testing the effects of a higher vegetable consumption on weight loss was undertaken.[4] The trial was approved by the University of Wollongong Human Research Ethics Committee and registered with ANZCTR [#1260000784011]. Participants provided written informed consent.

Baseline participants included n=113 healthy, overweight adults from the Illawarra region, NSW, Australia **(Supplementary material)**. Participants were screened for vegetable consumption type (fresh, dried, canned or frozen). Those not eating vegetables or extreme vegetarians were excluded. This secondary analysis focussed on vegetable intakes only. Both arms were given structured advice indicating intervention serving sizes double that of the control arm. Vegetable categories remained the same and advice encouraged increased variety based on vegetable colour. Total kilojoule intake was restricted to 80% of estimated energy requirements modelled for comparable macronutrient intakes in both arms. Dietary intake was assessed using a diet history interview following a validated proforma at baseline 3, 6, 9 and 12 months. Dietary data was analysed using Foodworks (v6.0.2562, Xyris Pty Ltd, QLD, Australia) software using the AUSNUT 2007[5] food composition database. Mixed meals were considered by individual ingredients. Vegetable data was extracted and separated into 34 botanically and conceptually similar categories. Statistical analyses used SPSS (v19.0.0, IBM Corporation, USA). Screening questionnaire responses were collated and total and categorical vegetable intakes determined and rank ordered by category and timing. Serves equated to 0.5C

cooked vegetables. Analyses for vegetable type and variety employed a general linear model RMANOVA for parametric data with α=0.05.

The cohort was predominantly female (75.22%) and middle aged (M:49.57±9.13, F:48.73±9.53 y) and overweight (M:30.6±2.8, F:29.8±2.7kg/m^2). The majority were Australian-born (75.22%), employed (85.84%) with tertiary qualifications (60.18%).

Pre intervention all participants ate at least two vegetable types with one participant not eating fresh vegetables. There was a significant increase in total vegetables consumed between baseline (345±170(56-920)g/d) and three months (498±180(146-930)g/d) continuing to 12 months, (475±169(170-1053)g/d) (p=0.001) mirrored in energy contributions from vegetables (p=0.000) **(Figure 1)**. At baseline the total number of vegetable categories was 32. Median categories increased between baseline (12, 5-19 categories) and each time point thereafter (p=0.004) **(Table 1)**. Despite only 62 (54%) participants reporting legume intakes pre intervention, legumes at three months increased to 77 (70%) and to 39.55±51.77g per participant (p< 0.001) sustained to 12months.

The top 30% (10 of 34) of vegetables eaten **(Table 1)** contributed 70 to 78% of the total weight of all vegetables. The least eaten categories included broad beans, fennel, artichoke, parsnip, turnip/swede. Vegetables which increased in popularity as the seasonal temperatures decreased (three to six months), included mixed vegetables and pumpkin (p<0.001). Legume consumption increased from baseline, ranked #11 moving to #5 at 12months (p<0.001, **Table 1**).

As tomatoes and potatoes were increasingly popular, further analyses were conducted. Many forms of tomatoes were used, including canned, dried, paste, puree, soups and salsa, with 72-88% fresh tomatoes. Tomato intakes were greater at three and 12months compared to baseline (p=0.004 and 0.002, respectively), declining during the cooler months (p=0.00), and increasing again at nine months (p=0.047) as seasonal temperatures increased. Potatoes were baked, boiled, mashed, fried, battered or as potato salad. There was a decrease in intake of potatoes (p=0.04) particularly 'fried' potatoes (p=0.009) over 12months.

DISCUSSION

With targeted dietary counselling, nearly 80% of the cohort increased and maintained their consumption for 12months. Intakes at baseline may relate to knowledge of recommendations to eat more vegetables. A high number of tertiary qualified, employed females may also contribute to the high reported intakes as employment and education are barriers to consumption. It may be argued that participants were highly motivated (77.5% retention rate) sustained by repeated counselling and positive feedback encouraging the sustained increase in vegetables. Conversely, high levels may be indicative of social desirability bias due to the interview administered dietary assessment used as well as characteristics associated with misreporting (overweight females).[6]

Approximately 75% of reported vegetables represented only ~30% of vegetable categories suggesting a reluctance to expand vegetable choices. Variety offers synergistic effects and does not increase energy as choice is independent of increased total energy of a meal.[7] Confidence to cook may also have implications for choice also influenced by family members.

Vegetable popularity fluctuated though energy contributions were consistent after the intervention advice. Although in Australia, a wide variety of fresh vegetables are available year round, seasonality should be paralleled. The least popular vegetables (parsnip, turnip or swede) were less available during summer months and it is suggested that the year round popularity of tomatoes and potatoes could be explained by the versatility of these vegetables.

Tomatoes are culturally eaten as a vegetable, available in many varieties and used in dishes across different cuisines. Similarly, in America, tomatoes are the non-starchy vegetable consumed in the highest quantity.[8] Decreased in potato consumption was seen though boiled potatoes did not decline likely due to the intervention advice related to a positive relationship between weight gain and fried, boiled, baked or mashed potato consumption. An inverse association is seen for increased vegetable consumption.[9]

Limitations to this analysis include the convenience clinical cohort sample, but the context enabled observations as a result of advice promoting vegetables. Collapsing vegetables into categories and limitations to food composition data required alternate choices as growing conditions would impact the nutrient data overall.[10] The mixed vegetable category included unknown mix combinations and weight may skew results for lighter vegetables contributing to lower rankings.

Despite already high reported consumption, participants increased and maintained vegetable intakes for one year though even for a motivated, educated cohort, expanding the variety of vegetables was difficult. While variety expanded lower intakes of the less popular vegetables continued. Repeated exposure with novel ways to introduce vegetables, may increase variety of less popular vegetables eaten in households.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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161 **Figure legends**

162

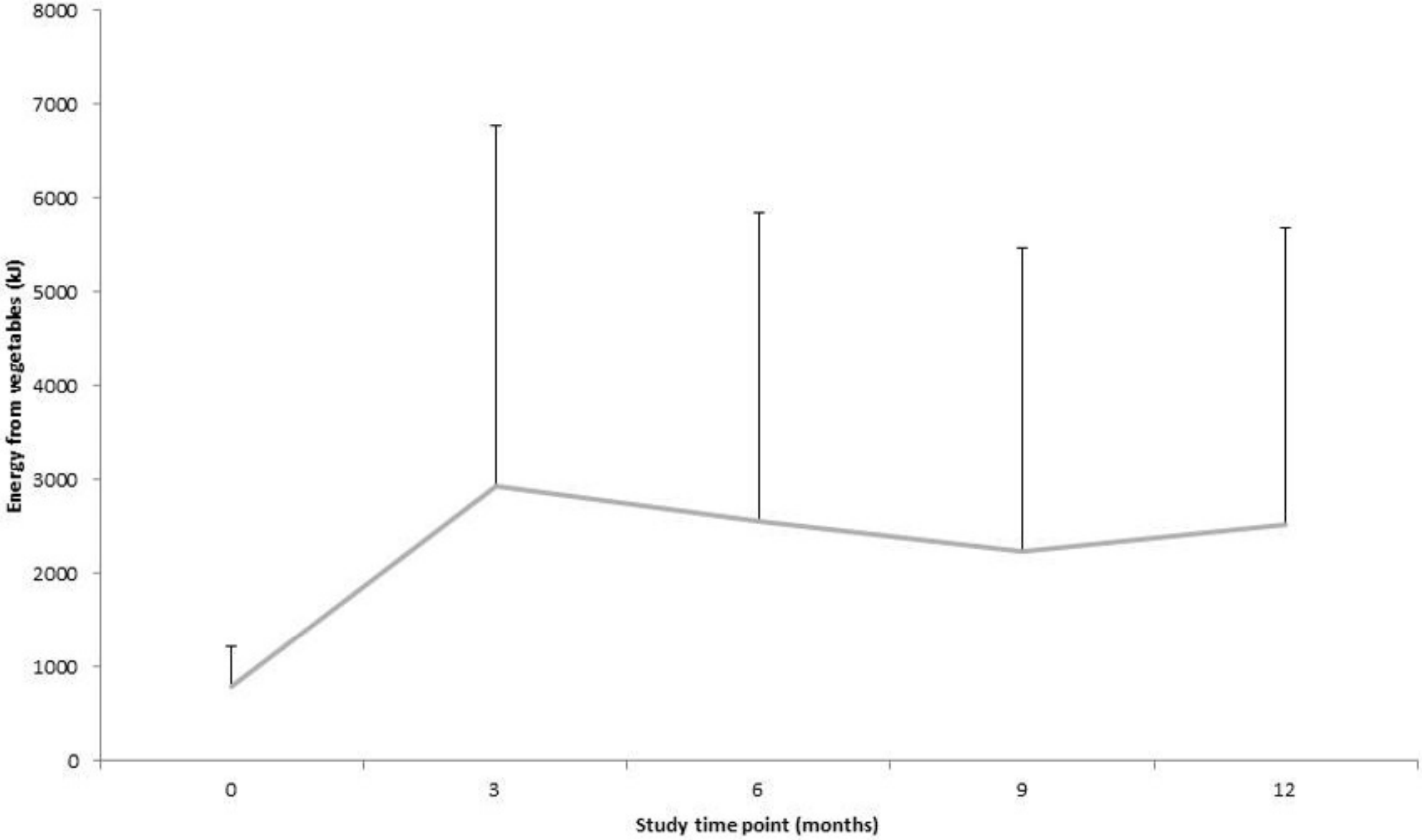
163 **Figure 1**: Total energy contribution from vegetable consumption (g) (mean ±SD) between t= 0 and

164 t=12 months (n=113)

Table 1: Vegetables by weight, number of serves and category consumed per participant per day including top ranked vegetables by weight

	Baseline n=113	**3 months n=109**	**6 months n=97**	**9 months n=89**	**12 months n=92**
Season	Spring-Summer	Summer-Autumn	Autumn-Winter	Winter-Spring	Spring-Summer
Total,[a] g	345±170	498±180*	466±176	462±188	475±169
> 5 serves, %	33.6	72.4	69.0	66.2	71.7
> 4 serves, %	54.8	85.3	81.4	82.0	85.9
> 3 serves, %	69.9	97.2	96.9	91.0	93.4
No. categories[b]	12 (5-19)	14 (6-20)	15 (7-20)	14 (8-23)	14 (7-23)
Tomato	1	1	1	1	1
Potato	2	4	4	3	3
Cucumber	3	3	10	7	4
Carrot	4	2	3	2	2
Broccoli	5	8	7	6	6
Lettuce	6	9	15	10	7
Leafy green/cabbage	7	10	9	8	10
Onion/leek	8			11	9
Capsicum	9	7	8	9	8
Avocado	10				
Legume	11	6	5	5	5
Mixed veg	12	5	2	4	
Sweet potato	13	12	14	12	11
Pumpkin	14	13	6	14	15
Peas	15				

[a] mean±SD, [b] median, IQR, *p<0.05 RMANOVA, one serve = 0.5C cooked vegetable.


8000
7000
6000
5000
4000
3000
2000
1000
0
Energy from vegetables (kJ)
0
3
6
9
12
Study time point (months)