

Fruit Juice and Diet Quality

SQUEEZING OUT THE EVIDENCE

A SUMMARY OF FINDINGS ON THE ASSOCIATION
BETWEEN FRUIT JUICE AND DIET QUALITY



MARCH 2013

A review of the scientific literature revealed:

Overall, the consumption of fruit juice is associated with improved nutrient adequacy, and better diet quality in children and adults.



Among children:

- Fruit juice consumption is associated with significantly higher intakes of four essential vitamins and minerals: folate, vitamin C, magnesium and potassium
- Fruit juice consumption is associated with significantly higher intakes of dietary fibre



Among adults:

- Fruit juice consumption is associated with significantly higher intakes of vitamin C
- Fruit juice consumption is associated with significantly higher intakes of dietary fibre

Background

Fruit juice consumption has been associated with better diet quality.

Findings from a re-analysis of the 2007 Australian National Children's Nutrition and Physical Activity Survey by Flinders University revealed that when fruit juice was consumed, the diet was found to be significantly lower in total and saturated fat, and significantly higher in total folate, carbohydrates, vitamin C, pro-vitamin A, magnesium and potassium¹. As such, the overall impact of fruit juice intake on diet quality is positive.

Data from the USA National Health and Nutrition Examination Survey (NHANES) showed that among children and adolescents, fruit juice (100%) consumers were more likely to meet their daily targets for vitamin A, vitamin C, folate, potassium and magnesium compared to non-consumers of fruit juice².

Review of the Scientific Literature

To further explore the balance of evidence in relation to fruit juice and diet quality, a review of the scientific literature was commissioned by Fruit Juice Australia, and conducted in September 2012.

Studies were excluded if they: were not peer reviewed; investigated fruit drink; combined fruit and vegetable juice; were conducted in animals, or were published prior to 2002 (unless particularly relevant). In this review, fruit juice was defined as 100% fruit juice, freshly squeezed, canned or bottled, composed exclusively of one or more fruits with no added sweeteners or sugar.

- The review identified twelve studies, of which, eight were in children²⁻⁹; two were in adults^{10,11}; and two were in both children and adults^{12,13}. The majority of the studies identified were conducted in the US population (with the exception of a single Japanese adult study), and published within the last decade.
- Seven of the 12 studies showed positive associations for fruit juice and diet quality; five showed mixed associations (combination of positive and negative). No studies showed only negative associations for fruit juice and diet quality.
- Nine of the 12 studies were cross sectional (Level IV evidence); one retrospective cohort (Level III-3 evidence); and two prospective cohorts (Level III-2 evidence).



FAST FACT

Fruit Juice Australia defines fruit juice as $\geq 99\%$ unsweetened fruit juice, with no added sugar. This definition allows for the addition of nutrients that may be lost in processing, consistent with current food standards in Australia.

WHAT IS THE WEIGHT OF EVIDENCE FOR FRUIT JUICE AND DIET QUALITY?

POSITIVE ASSOCIATIONS

7 Studies
(5 in children;
1 in adults;
1 in both children
and adults)

MIXED ASSOCIATIONS (combination of positive & negative associations)

5 Studies
(3 in children;
1 in adults;
1 in both children
and adults)

NEGATIVE ASSOCIATIONS **0 Studies**

Mixed associations = studies which found both positive and negative associations with fruit juice consumption e.g. fruit juice associated with higher vitamin C, but lower B vitamins; or fruit juice associated with improved diet quality only at certain quantities.

- There was great variability in serving size and frequency of juice consumption across the studies. In some cases, “consumers” were those who consumed any amount of fruit juice on the day of the survey; some studies ‘clustered’ consumers into ranges by either the amount of juice consumed or by the frequency of consumption (e.g. 0 – 121mls, 122-222mls and >222mls; and rarely, <2 times/week, 3-4 times/week and almost daily). Other studies compared the consumption of fruit juice according to American Academy of Pediatric (AAP) recommendations¹⁴:

- 4-6 fl. oz. (118 – 177ml) for children aged 0-6 years, and
- 8-12 fl. oz. (237 - 355ml) for children aged 7-18 years.

STUDY POPULATION: CHILDREN

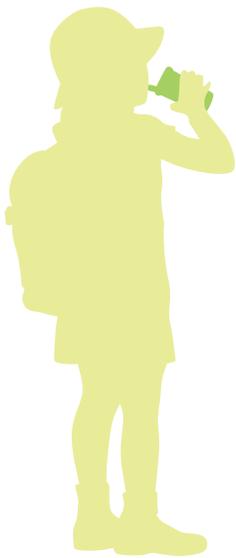
Eight studies were identified in children, from 1-18 years of age, in the US population. Five of the studies showed positive associations, with the other three concluding mixed associations with fruit juice consumption and diet quality.

Of those five studies showing positive associations, the nutrients found to be more adequate in children who consumed fruit juice (compared to non-consumers) included: folate, vitamin C, iron, potassium, magnesium, phosphorus, protein, fibre, vitamin A, vitamin C and vitamin B6. The papers by O’Neil et al^{2,5} and the study conducted by Nicklas et al⁶, which were large population studies (n =7250, n = 7250 and n = 3618, respectively), conducted in nationally representative samples, concluded that 100% fruit juice consumption is associated with improved nutrient adequacy and diet quality, and should be encouraged as part of a healthy diet.

Two of the three studies in children that concluded mixed associations between fruit juice consumption and diet quality, assessed diet quality using the C-DQI tool and the AAP recommendations, respectively^{9,7}. Both of these tools ‘penalise’ excessive fruit juice consumption in terms of diet quality, at intakes greater than 6 oz./day (>177 ml/day). The authors concluded that fruit juice consumption is positively associated with diet quality only at servings of \leq 4 oz./day (118 ml/day).

The third study in children resulting in mixed associations was conducted by Marshall et al⁸. Whilst fruit juice consumption was associated with higher intakes of protein and vitamin C, it was also associated with lower intakes of thiamine, riboflavin, niacin, energy, phosphorus, selenium, zinc and iron.

The combined results of the studies conducted in children conclude that consumption of 100% fruit juice is associated with improved nutrient adequacy and diet quality, and can therefore be encouraged as part of a healthy diet.



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“Consumption of 100% fruit juice is associated with improved nutrient adequacy and can contribute to a healthy diet”²

STUDY POPULATION: ADULTS

Only two studies were identified in adults^{10,11}, with results being both positive and mixed. The study by Eshak et al¹⁰, whilst investigating the association of particular beverages to the risk of developing Type 2 Diabetes, concluded that those who consumed fruit juice ‘almost every day’ had higher intakes of magnesium, calcium, energy and fibre.

Demydas et al¹¹ compared the nutrient profile of fruit juice consumers with that of both high- and low fruit and vegetable consumers. They concluded that whilst those consuming fruit juice had higher intakes of vitamin C, they had lower intakes of fibre, potassium, calcium, magnesium and vitamin A. A comparison between fruit juice consumers and non-fruit juice consumers was not investigated. Therefore, an association for fruit juice consumption and diet quality could not be determined.

STUDY POPULATION: BOTH CHILDREN AND ADULTS

Two cross-sectional studies were identified in both children and adults. Wang et al¹³ investigated the association of fruit juice with macronutrient intake (protein, carbohydrate, total and added sugar, total fat, saturated fat, mono-unsaturated fat and polyunsaturated fat), energy intake and body composition.

Only those consuming >222 ml/day had significantly higher intakes of energy, carbohydrate, total sugar, total fat and fatty acids (SFA, MUFA and PUFA). However, the authors note that these trends remained unchanged when orange juice was excluded from the list of foods consumed, and acknowledge that other factors may influence the association.

O’Neil et al¹², investigated diet quality using the Healthy Eating Index 2005 (HEI-2005) tool, and concluded that despite some age groups exceeding the AAP recommendations for fruit juice intakes, fruit juice consumption was associated with better diet quality in all age groups and should be encouraged in moderation as part of a healthy diet.

IN SUMMARY

Overall, results of this review indicate a predominantly positive association between fruit juice consumption and diet quality. However, given the variability in the serving sizes used across the studies, it is not possible to recommend an ideal serve size, which is consistent with improved diet quality.

SUMMARY OF RESULTS FROM THE REVIEW

	Author	Study Type	No. participants	Age (years)	Juice Type	Association of fruit juice and diet quality
CHILDREN	LaRowe et al 2007	XS	1334	2-11	100% (grapefruit, orange, apple, nectars)	+
	Skinner et al 1999	PC	105	2-3	100% (type NS)	+
	O’Neil et al 2012	XS	7250	2-18	100% (type NS)	+
	O’Neil et al 2011a	XS	7250	2-18	100% (type NS)	+
	Nicklas et al 2008	XS	3618	2-11	100% (type NS)	+
	Kranz et al 2006	XS	5437	2-5	100% (type NS)	-/+
	Marshall et al 2005	RC	645	1-5	100% (type NS)	-/+
	Kranz et al 2004	XS	8555	2-5	100% (Type NS)	-/+
ADULTS	Eshak et al 2012	PC	27,585	40-59	100% (type NS)	+
	Demydas et al 2011	XS	2444	20-59	100% (fresh, bottled, canned, type NS)	-/+
BOTH	O’Neil et al 2011b	XS	16111	2+	100% squeezed or concentrate (type NS)	+
	Wang et al 2012	XS	133,971	4+	100% orange	-/+

XS = Cross Sectional; RC = Retrospective Cohort; PC = Prospective Cohort
+ positive association; - negative association; +/- mixed association



FAST FACTS: KEY ROLES OF NUTRIENTS¹⁵

FOLATE

- Necessary for normal blood formation
- Necessary for normal cell division
- Contributes to normal growth and development in children

VITAMIN C

- Contributes to iron absorption from food
- Necessary for normal connective tissue structure and function
- Contributes to normal growth and development in children
- Contributes to the normal immune system function

MAGNESIUM

- Contributes to normal growth and development
- Necessary for normal nerve and muscle function
- Necessary for teeth and bone structure
- Necessary for normal cell division
- Contributes to normal growth and development in children

DIET QUALITY TOOLS – WHAT ARE THEY?

Traditional dietary assessment methods focus on individual nutrients and foods, rather than the overall quality of the diet. Many large scale epidemiological studies focus on the relationship between diet, or a component of the diet (i.e. single nutrient, food or food group) and risk of chronic disease. However, these associations do not reflect combined dietary behaviour and the effect that a diet has on disease risk, as foods and nutrients are not consumed in isolation. Therefore, diet quality assessment measures have been developed, which measure both nutrient intake and diet variety to assess the quality of the total diet. Examples include the Healthy Eating Index 2005 (HEI-2005) and C-DQI.

These tools are often related to national dietary guidelines that are set to reduce disease risk (i.e. target amount of saturated fat to reduce heart disease). Some tools are simple, while others are more complex and depend on the extent of nutrient targets and foods or food groups included in the tool. Generally, diet quality tools are based on: 1) intakes of nutrients; 2) indices based on the consumption of specific foods or food groups, or a combination of both.

A NOTE ON ENERGY AND DIET QUALITY

The macronutrients protein, fat and carbohydrates are sources of energy and hence, tend to be highly correlated to total energy intake. Micronutrient intake is also often well correlated with energy intake. Thus, diets high in energy can be either high or low quality, depending on the criteria used to measure diet quality. Therefore, energy is not a measure of diet quality per se, but is highly associated with diet quality. For the purpose of this review, energy has not been included in reference to 'diet quality'.



How much is enough?

The variability in the quantities of fruit juice that were investigated in this review makes it difficult to determine an ideal daily amount.

The two studies conducted by Kranz et al⁷⁹, indicate that positive associations in children are only evident at intakes \leq 4 oz. /day serves (\leq 118mls). In the study by Wang et al¹³, the authors indicate diet quality (some macronutrients) is reduced in children and adults at intakes greater than 222ml/day.

In contrast, the study conducted by O'Neil et al¹², indicated that diet quality was not compromised even despite the younger age group (2-5 years) exceeding the AAP recommendations. Therefore as a result, an ideal amount consistent with improved diet quality cannot be determined.

The Australian Dietary Guidelines¹⁶, state that fruit juice can be included as part of a balanced diet, because of its contribution to the recommended two daily serves of fruit. The recommended serving size is 125ml or $\frac{1}{2}$ cup of 100% fruit juice. Fruit Juice Australia supports the guidelines' preference for fruit in meeting the recommended serves due to their higher fibre content.



Implications

It is important to note that there are inherent limitations in interpreting dietary data from cross-sectional studies, and findings should be interpreted with caution.

The findings from this review do not suggest causality and future studies investigating the effect of fruit juice on overall diet quality are warranted. The fact that the majority of the cross-sectional studies show a positive association with micronutrients may indicate a true association.

Hence, fruit juice consumption may be a marker for nutrient rich diets.

The results of this review show associations between fruit juice and diet quality; they do not imply causality.

Nutrient composition of fruit juice



FAST FACTS: KEY ROLES OF NUTRIENTS¹⁵

POTASSIUM

- Necessary for normal water and electrolyte balance
- Contributes to normal growth and development in children
- Contributes to normal functioning of the nervous system
- Contributes to normal muscle function

DIETARY FIBRE

- Essential for proper functioning of the gut
- Promotes:
 - Laxation
 - Reduction in blood cholesterol
 - Modulation of blood glucose



FAST FACT

Per 100g, fruit juices and their whole fruit counterparts are nutritionally similar (aside from dietary fibre), including the total sugar and energy content.

Fruit juices can play an important role as part of a healthy diet – fruit juice is an important source of fluid and can provide vitamin C, folate, potassium and a range of other micronutrients (see Table 1). In addition to nutrient content, fruit juice contains antioxidants such as anthocyanin, catechin and phenols¹⁷. Per 100g, fruit juices and their whole fruit counterparts are nutritionally similar (aside from dietary fibre), including the total sugar and energy content.

TABLE 1. NUTRIENT COMPARISON OF SELECTED FRUIT JUICES AND THEIR WHOLE FRUIT COUNTERPARTS*

Nutrient (per 100g)	Orange juice	Orange, whole	Pineapple juice	Pineapple, raw	Grapefruit juice	Grapefruit, raw	Apple juice	Apple, green with skin
Energy (kJ)	116	175	193	178	126	138	126	204
Water (g)	92.4	86.7	92.6	86.8	96.2	88.3	92.6	85
CHO (g)	5.6	8.0	10.8	8.2	6.3	5.4	7.3	10.6
Sugars (g)	5.6	8.0	10.8	8.2	6.3	5.4	7.3	10.4
Fibre (g)	0.3	2.4	0	1.8	0	1.7	0.2	2.4
vit C (mg)	70	53	13	17	64	40	1	5
Folate (µg)	53	43	8	-	5	14	33	0
Calcium (mg)	7	25	6	20	9	24	7	4
Potassium (mg)	151	147	150	151	105	135	125	107

*Adapted from Landon S. Fruit juice nutrition and health. Food Australia 2007; 59(11):533-538. Nutrient composition data updated with NUTTAB 2010.

However, fruit juices are often incorrectly included in the sugar sweetened beverages category, which include fruit drinks (with added sugar), soft drinks, energy drinks and sports drinks. Yet, their nutrient profile differs markedly. For example, 100% orange juice contains fewer kilojoules; more than double the fibre; and around half the amount of sugar, compared to the same quantity of orange fruit juice drink (25% juice). See Table 2

TABLE 2. NUTRIENT COMPARISON BETWEEN 100% ORANGE JUICE AND ORANGE FRUIT DRINK

Nutrient (per 100g)	Orange juice (100%)	Orange fruit drink (25%)
Energy (kJ)	116	184
Fibre (g)	0.3	0.1
Total sugars (g)	5.6	10.9

*NUTTAB 2010

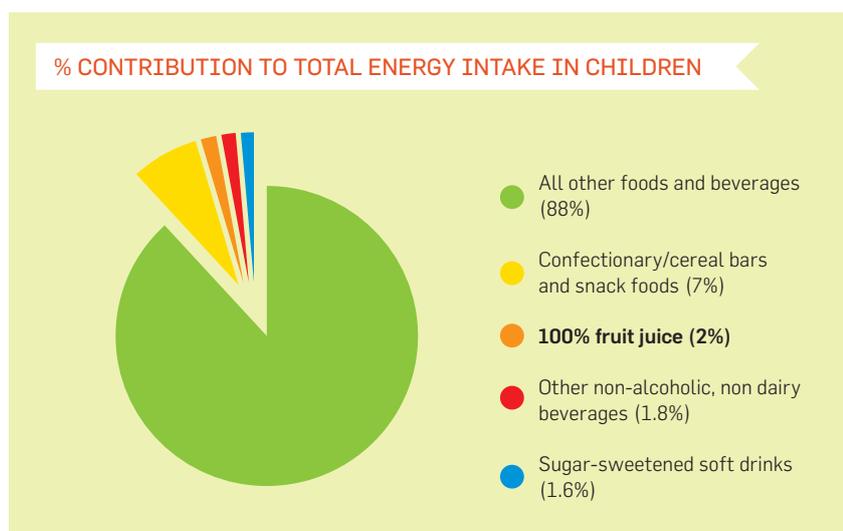
How much fruit juice are we currently drinking?

CHILDREN

Data from the 2007 Australian National Children's Nutrition and Physical Activity Survey¹⁸ showed that children, on average consumed around 120mls (approx. one small glass) of fruit juice on the day of the survey, which contributed around 2% of total energy intake (see chart below).

ADULTS

A CSIRO analysis of the 1995 National Nutrition Survey¹⁹, indicates that adult men consume an average of 70ml/day and adult women just 63ml/day. In terms of energy, fruit juice provides 1% of energy to adults over 19 years.



KEY FINDING:

2007 NATIONAL CHILDREN'S NUTRITION AND PHYSICAL ACTIVITY SURVEY

Findings from a re-analysis of the 2007 Australian National Children's Nutrition and Physical Activity Survey¹, revealed that fruit juice consumption is associated with dietary positives – significantly lower total and saturated fat, and significantly higher in total folate, carbohydrates, vitamin C, pro-vitamin A, energy, magnesium, total sugars and potassium.



FAST FACT

FRUIT JUICE AND FIBRE

Optimising total fibre intake is often cited as a reason to limit fruit juice, given that juices are inherently lower in fibre than their whole fruit counterparts. However, the results of this review showed that in both adults and children, fibre intake is generally not compromised in the diets of fruit juice consumers compared to those who do not consume fruit juice.



FAST FACT

FRUIT JUICE AND MILK

There is a common belief that children (in particular) who consume fruit juice may compromise their calcium intake, by replacing milk with fruit juice⁴. The results of this review reveal otherwise. Several studies included in this review conclude that consuming 100% fruit juice does not displace milk from the diet^{5-8, 12, 13}.

Discussion

Fruit juice can play an important part in a healthy diet, providing a useful source of fluid, as well as vitamin C, folate, potassium and a range of other micronutrients. Fruit juice may also be useful in helping younger Australians to meet their recommended daily fruit serves.

The 2007 Children's Survey revealed that fruit intake was generally below recommended levels, with some age groups particularly low. The Flinders re-analysis¹ states that only 1% of children 14-16 years consumed the recommended amounts of fruit serves. Yet when fruit juice was included as a fruit serve (as is consistent with the Australian Guide to Healthy Eating), one in five (i.e. 24%) of this group of children met the recommended number of serves of fruits. Likewise, for children aged 9-13 years, those who meet the recommended fruit serve intake increases from 51% to 90% when fruit juice is included. This finding is particularly relevant for non-fruit or low fruit consumers, as a way of helping to improve diet quality.

Based on these findings, 100% fruit juice can be included in moderate amounts as part of the recommended two serves fruit/day.



100% fruit juice can play an important role in helping children to meet their fruit serve recommendations

Conclusion

The literature on fruit juice consumption and diet quality suggests fruit juice is associated with better diet quality. Specifically, in children, fruit juice consumption is associated with significantly higher intakes of four essential vitamins and minerals: folate, vitamin C, magnesium and potassium.

In adults, fruit juice consumption is associated with significantly higher intakes of vitamin C. In both children and adults, fruit juice consumption is associated with significantly higher intakes of fibre.



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