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Dietary intake of calcium, vitamins A and E and bleeding on probing in Sri Lankan preschoolers

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Objective: To determine the prevalence of gingival bleeding on probing and the associations between dietary intake of calcium, vitamins A and E and gingival bleeding on probing in Sri Lankan preschool children. ***Basic Research Design:*** A cross-sectional study. ***Participants:*** 784 children aged 48-72 months attending preschools in the Kegalle district and their mothers/carers. ***Results:*** The prevalence of gingival bleeding on probing was 52.9%. A Poisson logistic regression model revealed that children with a high daily dietary intake of calcium were less likely to have gingival bleeding on probing than those with low intake (PR=0.80; 95%CI 0.64,0.98). Also prevalence of gingival bleeding was higher in children: with plaque on their teeth; whose mothers were not employed; or, were from families with three or more children. ***Conclusions:*** The prevalence of gingivitis was high in the children and the findings suggest that high levels of dietary calcium intake are associated with reduced gingival bleeding in preschool children.

Key words: *calcium, vitamin A, vitamin E, gingivitis, Sri Lanka, dietary intake*

Introduction

Nutrients are necessary to maintain periodontal health and micronutrients such as calcium, folic acid and vitamins A, C and E are considered to play an important role in this regard (Moynihan, 2008). Vitamin A is necessary for maintaining the integrity of the epithelium and a deficiency of vitamin A may have adverse effects on gingival tissues. Vitamin C is required for collagen synthesis and immune function and therefore important for periodontal health. A deficiency of folic acid could reduce the ability of the gingival tissue to act as a barrier to bacteria. In addition, the antioxidant properties of vitamins A, C and E can reverse the damage caused by free radicals such as reactive oxygen species which are produced as a result of hosts' responses to periodontal pathogens (Chapple, 2009; Moynihan, 2008; Ritchie and Kinane, 2003). It has been stated that dietary calcium can modulate periodontal disease through its effect on bone mineral density (Schifferle, 2009) and low dietary intake of calcium may result in more severe periodontal disease (Nishida *et al*., 2000)

Chronic gingivitis which is characterised by inflammation of the marginal gingiva without loss of periodontal attachment or bone is the most common form of periodontal disease affecting young children. The early signs associated with this condition include redness and swelling of the gingiva and bleeding on probing (Oh and Wang, 2002). Recent studies indicate that the prevalence of gingivitis among preschool children ranges from 4-30% and the presence of dental plaque as well as socio-demographic factors such as gender, family income, fathers' and mothers' level of education are associated with gingivitis in this group (Al-Haddad *et al*., 2013, Cortellazzi *et al*., 2008, Leroy *et al*., 2011).

The links between nutrition and periodontal health have been mainly investigated in adults. As chronic gingivitis is an inflammatory condition and nutrients modulate inflammation it would be of interest to determine the effect of micronutrients on gingival health of preschool children. Moreover it is evident from the literature that the association between nutrition and gingival health in preschool children is yet to be investigated. Therefore the aims of the present study were to determine the prevalence of gingival bleeding on probing in Sri Lankan preschool children and any associations between gingival bleeding on probing and dietary intake of the micronutrients calcium, vitamin A and vitamin E which are considered particularly important in maintaining periodontal health.

Methods

Ethical clearance for the study was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Colombo. Permission to conduct the study was also obtained from the Regional Director of Health Services and the Zonal Director of Education, Kegalle district. Written informed consent was obtained from children's parents/carers (hereafter mothers). Children who were medically compromised, physically or mentally challenged were excluded.

This study was conducted among children aged 48-72 months attending preschools in the Kegalle district. The calculation of sample size used the national survey reported prevalence of bleeding on probing in 6 year olds (57%, Ministry of Health, 1997) at 95% level of

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confidence and accepting a sampling error of 5% giving a sample size of 377. Taking into account cluster sampling technique (design effect 2.0) and 15% compensation for potential non-responses gave an intended sample of 867.

As cluster sampling technique requires at least 30 clusters for validity with more small clusters being preferable to fewer large clusters (Kirkwood and Sterne, 2004), it was decided to select 10 children per cluster so 87 clusters were required (867/10≈87). Preschools were taken as the primary sampling unit (cluster). Sri Lankan districts are divided in to Divisional Secretariat Divisions (DSDs) for administration. The 87 clusters were allocated across the 10 DSDs based on the probability proportionate to size technique and then selecting equal numbers of children from each cluster gives each child in the population the same probability of selection (Bennett *et al*., 1991). The clusters from a given DSD were selected by first locating the main street of the DSD then the closest preschool was selected as the first cluster for that division. Next the preschool closest to the first was selected as the second cluster and so on until the required number of clusters was selected for the DSD. Ten children aged 48-72 months were selected randomly from each preschool.

A semi-structured, self-administered questionnaire was used to obtain data on socio-demographic information and oral health related behaviours. Information on habitual dietary intake including micronutrients was obtained through a validated, self-administered 95-item semi-quantified food frequency questionnaire (FFQ). The FFQ was developed based on information from the Department of Nutrition, Medical Research Institute, Sri Lanka about foods/drinks consumed by the Sri Lankan population and an interview with a group of mothers of preschool children from the area. The 95-items of food and drink included in the FFQ could be categorised into eight major food groups; milk and milk products, cereals and cereal products, egg, meat and fish, desserts, sweets and sweetened beverages, fruit, vegetables, green leave and tubers, legumes and miscellaneous. The frequency of intake over the past 3-months was recorded on a 4-point scale: never/rarely, times per day/week/month as appropriate and the portion sizes based on standard household measures used in Sri Lanka; spoons of different sizes, tea cups, glasses, slice of bread. For meat and fish a medium portion was defined as the amount equivalent to the size of two matchboxes. Where applicable the respondents were requested to indicate the method of preparation of foods.

Data collection took place on school premises with questionnaires given to mothers in the presence of the first author who could answer any queries. For mothers lacking the necessary literacy skills a preschool teacher was available to assist. The first author assessed gingival bleeding on probing and the presence of plaque under natural daylight by running a periodontal probe along the cervical margins and the adjacent areas of teeth while the child was seated on a chair. Plaque and gingival bleeding on probing were recorded on 4 surfaces of 6 teeth; mesial, distal, buccal/labial and lingual/palatal surfaces of 55, 61, 63, 75, 81 and 83. The examiner was trained and calibrated against a paedodontist for recording these two entities. The questionnaires were pretested among 20 mothers of preschool children from the same district and based on the findings certain questions were rephrased for greater clarity. These 20 mothers and their children were excluded from the main study.

Data were analysed using STATA v12.0 software. Data from the FFQ were used to determine the daily intake of dietary calcium, vitamin A and vitamin E. Firstly, all frequencies of intake were converted to daily intakes, e.g. one portion 5 times a month, the daily intake became 5/30 portions daily and two cups twice a week became 4/7 cups daily. Secondly, the daily intake was converted to grams (ml for drinks) using guidelines developed by the Department of Applied Nutrition, Wayamba University Sri Lanka (see online appendix A). For cooked food a conversion factor from raw to cooked food was applied (see online appendix B). Finally food composition tables prepared by the Medical Research Institute was used to convert the daily intake of foods/drinks into available micronutrients (Perera, 1979) by finding the product of mass of each food eaten per day (in100s of grams) and the micronutrient content of that food per 100 grams. For each micronutrient (calcium, vitamins A and E), the total intake per day was summed for each child.

The daily intake of micronutrients was categorised into tertiles (high, medium and low) for analysis. Chi square test was used to determine the associations between categorical variables. Having excluded the presence of multi-collinearity, those socio-demographic and behavioural variables that were associated with bleeding on probing at $p<0.05$ level in the bivariate analyses and the micronutrient intake levels were included in a Poisson regression analysis with robust variance to determine the associations between the dependent and explanatory variables.

Results

All of the 838 mothers recruited for the study returned completed questionnaires but only 784 (94%) of their children participated in the oral examination. The mean age of the children was 57.3 (sd 6.2) months. Their mean daily dietary intake was 753 mg calcium, 940µg vitamin A and 30 mg vitamin E. Children with intakes below the recommended daily allowance for Sri Lankan 4-6 year olds were 29% for calcium, 19% for vitamin A and 5% for vitamin E. The median dietary intake was 685.5mg (range 229-1,943) for calcium, 771.1µg (148-3,867) for vitamin A and 24.7mg (3-158) for vitamin E.

Gingival bleeding on probing was present in 52.9% of the children and the median percentage of surfaces with bleeding on probing was zero (maximum 37.5%).

Table1 shows the associations between selected socio-demographic, behavioural variables, daily dietary intake of calcium, vitamins A and E and gingival bleeding on probing. There were significant associations between ethnicity, education level of father, employment status of mother, number of children in the family, presence of plaque and daily dietary intake of calcium and gingival bleeding on probing. According to the Poisson regression model, children who had plaque on their teeth (PR=1.90; 95%CI 1.52,2.38), whose mothers were not employed (PR=1.71; 95%CI 1.21,2.40) and were from families with ≥3 children (PR=1.22; 95%CI 1.04,1.44) were more

Table1. Associations between selected socio-demographic, behavioural variables, daily dietary intake of calcium, vitamins A, E and gingival bleeding on probing

Variable	*n*	*With bleeding on probing*		*No bleeding on probing*		χ^2 *test*
		n	*%*	*n*	*%*	*p*
Age group						
48 to <60 months	466	213	45.7	253	54.3	0.36
60 to 72 months	318	156	49.1	162	50.9	
Gender						
Boys	383	177	46.2	206	53.8	0.64
Girls	401	192	47.9	209	52.1	
Ethnicity						
Sinhala	704	319	45.3	385	54.7	**0.004**
Non-Sinhala	80	50	62.5	30	37.5	
Father's education (years)						
0 to 5	52	31	59.6	21	40.4	**0.03**
6 to 12	656	310	47.3	346	52.7	
Over 12	72	26	36.1	46	63.9	
Mother's education (years)						
0 to 5	35	22	62.9	13	37.1	**0.03**
6 to 12	636	303	47.6	333	52.4	
Over 12	109	42	38.5	67	61.5	
Employment status of mother						
Not employed	681	341	50.1	340	49.9	**<0.001**
Employed	99	28	28.3	71	71.7	
Monthly family income						
Rupees ≤13,000	371	185	49.9	186	50.1	0.12
Rupees >13,000	363	160	44.1	203	55.9	
Number of children in family						
Up to 2	617	273	44.2	344	55.8	**0.004**
3 or more	165	94	57.0	71	43.0	
Frequency of tooth brushing						
Once/day	87	32	36.8	55	63.2	0.10
twice/day	650	311	47.8	339	52.2	
More than twice/day	45	24	53.3	21	46.7	
Type of toothpaste used						
Fluoride	729	345	47.3	384	52.7	0.92
Non fluoride	43	20	46.5	23	53.5	
History of dental visits						
No	493	224	45.4	269	54.6	0.28
Yes	285	141	49.5	144	50.5	
Presence of plaque						
No	238	65	27.3	173	72.7	**<0.001**
Yes	546	304	55.7	242	44.3	
Dietary calcium intake (mg/day)						
Low (229.4 to <594.1)	259	138	53.3	121	46.7	**0.03**
Medium (594.1 to <830.2)	260	114	43.8	146	56.2	
High (830.2 to 1943.8)	261	113	43.3	148	56.7	
Dietary vitamin A intake (µg/day)						
Low (148.1 to <601.5)	259	120	46.3	139	53.7	0.97
Medium (601.5 to <978.9)	260	123	47.3	137	52.7	
High (978.9 to 3867.0)	261	122	46.7	139	53.3	
Dietary vitamin E intake (mg/day)						
Low (24.7 to <18.4)	259	111	42.7	149	57.3	0.26
Medium (18.4 to <31.5)	260	128	49.2	132	50.8	
High (31.5 to 158.7)	260	126	48.5	134	51.5	
Whole sample	784	415	52.9	369	47.1	

Calcium, vitamins A and E intake categorised into low, medium and high intake based on tertiles likely to have gingival bleeding on probing compared to children who did not have plaque, whose mothers were employed and were from families with less than 3 children. Also children with a high daily dietary intake of calcium were less likely to have gingival bleeding on probing compared to those with a low daily intake of calcium (PR=0.80; 95%CI 0.64,0.98) (Table 2).

Discussion

The prevalence of gingival bleeding on probing in this population was 52.9%. Methodological differences such as variations in the indices used to record the gingival status and the extent to which the gingivae were examined (partial- or full-mouth) for bleeding on probing make valid comparisons between studies difficult. Nevertheless the prevalence of gingivitis in the present study is much higher than reported for similar age groups elsewhere, e.g. prevalence of gingivitis in Yemeni 5-year-olds being 27% and only 3-4% of Flemish 3-5-year-olds having signs of gingival inflammation (Al-Haddad *et al*., 2013; Leroy *et al*., 2011). The higher plaque levels in the present study's children may explain the higher observed prevalence of gingivitis.

The daily intakes of the micronutrients calcium and vitamins A and E (considered important in maintaining the integrity periodontal tissues) were assessed for their associations with gingival bleeding on probing. There are no published data on these associations for this age group but comparisons can be made with other age groups. This study found that gingival bleeding on probing was lower in those with a higher intake of calcium. Petti *et al*., (2000) found that calcium intake of 17-19-year-old girls was significantly lower in cases with gingivitis. Also those who took calcium and vitamin D supplements had fewer bleeding sites and lower gingival index values, shallower pockets and less attachment loss (Miley *et al*., 2009). There are several potential explanations for this finding. As calcium is important for blood clotting, it could be assumed that low levels of calcium in blood due to low dietary intake may increase the tendency for gingival bleeding. Experiments with rats have shown that insufficient intake of calcium causes acute inflammatory reactions in periodontal tissues and disruption of the gingival epithelium (Shoji *et al*., 2007). This suggests that calcium may reduce the susceptibility to gingival inflammation through an anti-inflammatory effect.

Oxidative stress plays an important role in the pathogenesis of periodontal disease and dietary antioxidants could protect periodontal tissues from oxidative damage (Moynihan, 2008; Ritchie and Kinane, 2003). It has been stated that antioxidants can modulate gingival inflammation as well (Ritchie and Kinane, 2003). As vitamin E is a powerful antioxidant which also has anti-inflammatory properties (Reiter *et al* 2007) it could be effective in controlling periodontal disease. In fact, progression of periodontal disease was inversely associated with vitamin E intake in community-dwelling older Japanese (Iwasaki *et al*., 2013). Also low serum levels of α-tocopherol have been suggested as a risk factor for periodontal disease (Iwasaki *et al*., 2012). However vitamin E intake was not associated with bleeding on probing in this study. A dietary item may have excellent antioxidant properties but if it does not reach the target tissues in a bioactive form it may not have any clinical effect. The beneficial effects of a nutrient will also depend on its bioavailability (Milward and Chapple, 2013). Vitamin A intake was not associated with bleeding on probing in the present study and is in accordance with the findings of Petti *et al*., (2000).

Table 2. Poisson regression model for covariates associated with gingival bleeding on probing

Variable	*Prevalence ratio*	*95%CI*	*p*
Ethnicity			
Non-Sinhala	1.00		
Sinhala	1.13	0.94-1.36	0.16
Father's education			
0 to 5 years	1.00		
6 to 12 years	0.99	0.77-1.28	0.97
Over 12 years	0.85	0.56-1.29	0.46
Mother's education			
0 to 5 years	1.00		
6 to 12 years	0.94	0.71-1.23	0.66
Over 12 years	0.94	0.65-1.37	0.78
Employment status of mother			
Employed	1.00		
Not employed	1.71	1.21-2.40	**0.002**
Number of children in family			
Up to 2	1.00		
3 or more	1.22	1.04-1.44	**0.01**
Presence of plaque			
No	1.00		
Yes	1.90	1.52-2.38	**<0.001**
Dietary calcium intake			
Low	1.00		
Medium	0.84	0.70-1.01	0.06
High	0.80	0.64-0.98	**0.04**
Dietary vitamin A intake			
Low	1.00		
Medium	1.06	0.88-1.27	0.51
High	1.12	0.91-1.38	0.24
Dietary vitamin E intake			
Low	1.00		
Medium	1.09	0.91-1.31	0.31
High	1.10	0.89-1.36	0.34

Apart from dietary intake of calcium, presence of plaque was associated with gingival bleeding on probing. Plaque induced gingivitis is the most prevalent form of gingivitis in children (Oh and Wang, 2002) so this finding might be expected. Similar results have been reported elsewhere (Al-Haddad*et al*., 2013; Leroy *et al*., 2011). Also in the present study, children with unemployed mothers were more likely to have gingival bleeding on probing perhaps because employed mothers had higher levels of education. Maternal educational attainment may influence health literacy which in turn may affect the health including oral health of the child. Having three or more children in the family was associated with bleeding on probing and it is conceivable that parents of the larger families may not be able to give as much individual attention to the oral hygiene practices of the children.

There are a few limitations to the study. Dietary intake of micronutrients was obtained through a self-administered FFQ. Therefore recall bias may have influenced the results of the study. Also there is a possibility that the respondents may have selectively under-or over reported the frequency of consumption of certain foods/drinks. Furthermore the cross-sectional nature of the study precludes causal interpretation of results. As it was too time consuming and difficult to carry out a full mouth recording of gingival bleeding and plaque in young children, a partial recording method on 6 teeth was used. However, Goldberg *et al*., (1985) found very strong correlations between partial recordings on of six deciduous teeth and full mouth recordings of gingival state (r=0.94) and plaque (r=0.96) in 4-6-year-olds suggesting that the partial recordings used were likely to be sufficient.

In conclusion, the prevalence of gingivitis was high in the children of the present study. The findings also suggest that high levels of dietary calcium intake could be associated with reduced gingival bleeding in preschool children. To our knowledge this is the first study to assess the effect of the selected micronutrients on gingival bleeding of preschool children. Therefore it is recommended that further research be conducted to establish the associations between the intake of a wider range of micronutrients and gingival bleeding in preschool children.

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Online only appendices

Appendix A
Conversion ratios for foods' common measures into standard weight or volume

Food Item	Usual measurement		In g or ml
Milk Products			
Milkmaid	tablespoon	1	15g
Milk Powder - Diamond	teaspoon	1	5g
Milk Powder- Anchor	teaspoon	1	5g
Milk Powder -Nespray	teaspoon	1	5g
Liquid cows' milk	cup	1	140ml
Butter	teaspoon	1	10g
Milk Powder- Nido	teaspoon	1	5g
Astra margarine	teaspoon	1	10g
Curd	tablespoon	1	25g
Milk Powder -Lakspray	teaspoon	1	5g
Malted Milk Powder Nestomalt	teaspoon	1	6g
Happy Cow Cheese	wedges	1	17g
Yogurt small	cup	1	80g
Yogurt	tablespoon	1	20g
Ice Cream	small cup	1	80g
Ice Cream	tablespoon		
Sterilised Milk	small bottle	1	250ml
Milk Powder -Ratthi	teaspoon	1	5g
Malted milk drink- Milo	teaspoon	1	6g
Chocolate powder	teaspoon	1	4g
Milk Powder- Pediasure	teaspoon	1	4g
Milk Powder- Highland	teaspoon	1	5g
Milk Powder -Sustagen	teaspoon	1	5g
Milk Powder -Anchor	tablespoon	1	10g
Malted milk powder -Nestomalt	tablespoon	1	11g
Curd	teaspoon	1	11g
Curd	cups	1	128g
Flavoured milk- Nespray	pack	1	180ml
Flavoured milk-Daily	pack	1	200ml
Flavoured milk-Kotmale	pack	1	200ml
Malted milk drink-Milo	pack	1	180ml
Milk kanji	cup	1	140ml
Ice Cream & jelly together	cup	1/2	20g
Ice Cone	small	1	80ml
Corn flakes	tablespoon	1	10g
Cereal based food-Nestum	teaspoon	1	6g
Egg - Boiled		1	49g
Egg – Omelets		1	40g
Fish – Flying fish curry	small piece	1	16g
Fish – Sardinella deep fried	medium size	1	12g
	small size	1	8g
Fish – sprat curry	tablespoon	1	10g
Fish – sprat tempered	tablespoon	1	8g
Fish – sprat deep fried	tablespoon	1	7g
Dried Fish – Skipjack tuna	small piece	1	23g
Fish – Trenched sardine curry	small size	1	35g
Fish – Trenched sardine curry	medium size	1	40g
Fish – Trenched sardine curry	large size	1	45g
Fish – Skipjack tuna curry	small piece	1	15g
Fish – fresh water – deep fried	medium size	1	19g
Fish – fresh water – deep fried	small	1	14g
Fish – fresh water – deep fried	large	1	23g
Fish – fresh water - curry	medium size	1	33g
Fish – fresh water - curry	small	1	17g

Food Item	Usual measurement		In g or ml
Pork curry	small piece	1	10g
Dried Fish – Katta - curry	small piece	1	15g
Dried Fish – Katta - fried	small piece	1	6g
Fish – Trenched sardine deep fried	small	1	13g
Egg - Bull's-eye	small	1	38g
Canned Fish - fried	medium piece	1	32g
Chicken - curry	tablespoon	1	11g
Chicken – deep fried	medium piece	1	16g
Dried Fish – Keeramin deep fried	small	1	3g
Dried Fish – Keeramin deep fried	medium	1	6
Maldive fish	teaspoon	1	6g
Maldive fish	tablespoon	1	12g
Egg – half boiled		1	48g
Egg – boiled (only albumin)		1	34g
Egg – boiled (Yolk)		1	15g
Mutton -	small piece	1	6g
Sausages - fried	tablespoon	1	15g
Meat balls	medium	1	5g
Fish – Yellowfin tuna curry	small	1	16g
Fish – Yellowfin tuna curry	medium size	1	39g
Fish – Travallies - curry	medium size	1	22g
Chicken - Liver	small piece	1	8g
Vegetables / legumes			
Coconut melluma	tablespoon	1	18g
Coconut sambol	tablespoon	1	27g
Beans - curry	tablespoon	1	16g
Brinjal - curry	tablespoon	1	19g
Dhal - curry	tablespoon	1	24g
Dhal - fried	tablespoon	1	12g
Cowpea- boiled	cup	1	110g
Scraped coconut	tablespoon	1	8g
Ash plantain - curry	tablespoon	1	13g
Snake gourd - curry	tablespoon	1	18g
Jak fruit- Curry	tablespoon	1	18g
Jak fruit– Boiled	tablespoon	1	13g
Gravy	tablespoon	1	7g
Brinjal - fried	tablespoon	1	15g
Carrot - salad	tablespoon	1	12g
Pumpkin - curry	tablespoon	1	19g
Potato - curry	tablespoon	1	15g
Long beans -curry	tablespoon	1	15g
Long beans - fried	tablespoon	1	12g
Kekiri (cooking melon)- curry	tablespoon	1	20g
Tibbatu (Turkey berry) - mellun	tablespoon	1	9g
Egg plant - curry	tablespoon	1	10g
Papadam	medium size	1	6g
Banana flower-fried	tablespoon	1	31g
Chick-pea - boiled	cup	1	111g
Wing bean- curry	tablespoon	1	15g
Lufa - curry	tablespoon	1	19g
Carrot - curry	tablespoon	1	15g
Kiri-ala (Yam)- curry	tablespoon	1	20g
Kekiri (cooking melon)- ambula	tablespoon	1	12g
Peanuts - fried	seeds	14	1g
Cabbage - curry	tablespoon	1	18g
Dhal & spinach – curry	tablespoon	1	25g
Tomato - curry	tablespoon	1	9g
Lunumiris	teaspoon	1	10g
Soya– fried	tablespoon	1	16g

Food Item	Usual measurement		In g or ml
Green gram - boiled	cup	1	109g
Tibbatu (Turkey berry)- curry	tablespoon	1	11g
Jak fruit melluma	tablespoon	1	15g
Young jak fruit curry	tablespoon	1	19g
Cucumber curry	tablespoon	1	13g
Raddish - curry	tablespoon	1	19g
Raddish - fried	tablespoon	1	14g
Kathurumurunga - curry	tablespoon	1	10g
Beet root - curry	tablespoon	1	20g
Kohila (Lasiaspinosa)root - fried	tablespoon	1	18g
Capsicum - curry	tablespoon	1	25g
Cucumber – salad	tablespoon	1	17g
Potato - boiled	small potato	1	21g
Carrot - boiled	small carrot	1	20g
Sweet potato	small	1	27g
Bitter gourd - curry	tablespoon	1	20g
Bitter gourd - fried	tablespoon	1	18g
Bitter gourd - salad	tablespoon	1	13g
Lotus root -curry	tablespoon	1	17g
Drum stick - curry	tablespoon	1	16g
Kohila (Lasiaspinosa) leaves - curry	tablespoon	1	18g
Bean - fried	tablespoon	1	13g
Cow-pea - curry	tablespoon	1	9g
Green gram - curry	tablespoon	1	10g
Raw mango - curry	tablespoon	1	15g
Noodle Instant - Maggi	small pack	1	75g
Noodle Instant – Prima	½ pack	1	70g
Samaposhaaggala	ball	1	40g
Sandwich -		1	18g
Hoppers	medium	1	61g
Tomato salad	tablespoon	1	15g
Flat bean - curry	tablespoon	1	16g
Breadfruit - curry	tablespoon	1	20g
Mushroom - curry	tablespoon	1	13g
Seenisambol	teaspoon	1	7g
Green gram - curry	tablespoon	1	26g
Cucumber	small slice	1	9g
Okra – fried	tablespoon	1	17g
Okra –curry	tablespoon	1	22g
Manioc yam– boiled	large piece	1	40g
Knol kohl - curry	tablespoon	1	20g
Bread fruit - boiled	large piece	1	27g
Bread fruit - boiled	medium	1	20g
Bread fruit - boiled	small	1	14g
Vegetable salad	tablespoon	1	19g
Sweet potato	small piece	1	19g
Cashew curry	tablespoon	1	19
Leeks - curry	tablespoon	1	23g
Coconut sambola - fried	tablespoon	1	24g
Yellow split bean - curry	tablespoon	1	26g
Potato – deep fried	small piece	3	24
Amberella (Spodiascythera)– curry	small fruit	1	28
Mushroom - fried	tablespoon	1	10g
Mango-jak seed curry	tablespoon	1	16g
Red Onion	small pods	3	5g
Tomato	small fruit	1	25g
Manioc - curry	tablespoon	1	20g
Onion salad	tablespoon	1	11g
Brinjal pickle	tablespoon	1	13g

Food Item	Usual measurement		In g or ml
Carrot	small	1	35g
Leeks – potato - fried	tablespoon	1	18g
Drumstick leaves- mellun	tablespoon	1	12g
Beans - fried	tablespoon	1	15g
Mukunuwenna leaves (Alternantherasessilis)	tablespoon	1	10g
Kathurumurunga – (Sesbaniagrandiflora) salad	tablespoon	1	15g
Kathurumurunga leaves Sesbaniagrandiflora)	tablespoon	1	9g
Gotukola (Centella) salad	tablespoon	1	16g
Penella kola leaves	tablespoon	1	9g
Sarana (Boerhaviadiffusa) leaves	tablespoon	1	12g
Kohila (Lasiaspinosa) leaves	tablespoon	1	18g
Spinach leaves-	tablespoon	1	14g
Kalawanmelluma	tablespoon	1	10g
Kangkung leaves– (water spinach)fried	tablespoon	1	8g
Leeks - fried	tablespoon	1	12g
Cabbage leaf salad	tablespoon	1	12g
Fruits			
Rambutan	large	1	8g
Rambutan	medium	1	6g
Rambutan	small	1	4g
Papaw	small slice	1	31g
Papaw	tablespoon	1	15g
Orange - slice	medium	1	12g
Apple	small	1	109g
Apple	large	1	150g
Pine apple – slice	small	1	15g
Pine apple – slice	medium	1	20g
Pine apple – slice	large 1	1	30g
Fruit salad	cup	1	125g
Fruit salad	tablespoon	1	25g
Ripe jak fruit	medium	1	27g
Avocado	tablespoon	1	20g
Avocado	cup	1	124
Sweet melon - slice	small	1	40g
Sweet melon - slice	medium	1	50g
Grapes - fruit	small	1	4g
Cherry- fruit	medium	1	5g
Grape fruit– slice	medium	1	25g
Dates		1	6g
Cashew nut - slice		2	4g
Durian -	medium	1	10g
Plums		5	2g
Banana - ambul	small	1	25g
Banana - ambul	medium	1	39g
Banana - kolikuttu	small	1	25g
Banana - kolikuttu	medium	1	40g
Banana - ambun	medium	1	80g
Banana – seenikesel	medium	1	36g
Banana – seenikesel	large	1	45g
Banana - Anamalu	medium	1	85g
Mango – rata amba	fruit	1/2	46g
Mango – rata amba	large fruit	1	150g
Mango – Petti amba	small fruit	1	92g
Mango – Petti amba	small slice	1	16g
Mango - Karthakolomban	small fruit	1/2	56g
Mangoosteen	small fruit	1	27g
Mangoosteen	medium fruit	1	35g
Passion fruit	medium	1	18g
Uguressa fruit (a local cherry)	medium	1	7g

Food Item	Usual measurement		In g or ml
Orange – yellow fruit	medium	1	103g
Guava fruit	medium	1	43g
Mandarin - fruit	small	1	20g
Beli (Bael fruit)	medium slice	1	36g
Sugar cane -	large piece	1	19g
Weralu (local olive)fruit	small	1	8g
Pears	medium	1	158g
Wood apple fruit	medium	1	47g
Gal siyabala -fruit	medium	3	1g
Nelli - fruit	medium	1	7g
Pini (white) jambu fruit	small	1	14g
Ripe jak	medium	1	25g
Beling - fruit	small	1	5g
Jambu - fruit	small	1	4g
Jambu - fruit	medium	1	5g
Jam - fruit	small	10	2g
Cereal and flour			
Rice – red	cup	1	92g
Rice - parboiled	cup	1	93g
Rice – white raw	cup	1	91g
Rice - Niwdu	cup	1	90g
Biscuit – MuncheeTifin		1	4g
Bread	slice	1	22g
Bread	loaf	1/4	100g
Tea buns		1	50g
String hoppers	medium	1	8g
String hoppers	large	1	12g
Biscuit – Gold Marie		1	5g
Biscuit – Tikiri Marie		1	4g
Cream Bun		1	34g
Biscuit – Chocolate		1	12g
Thosai	medium	1	40g
Noodle – Instant - Maggi	cup	1	130g
Roti – kurakkan, a cereal of millet group	medium	1	180g
Roti – kurakkan - a cereal of millet group	small	1	160g
Biscuit – cream Cracker		1	20g
Milk rice – green gram	cup	1	126g
Biscuit – Wafers		1	5g
Roti - Vegetable	medium	1	110g
Wiskiringha	medium	1	25g
Roti – wheat flour	small	1	170g
Roti – wheat flour	medium	1	180g
Roti – wheat flour	large	1	190g
Biscuit -rusks		1	30g
Hoppers	medium	1	60g
Hoppers - egg	medium	1	105g
Chinese roles	medium	1	30g
Biscuits – Nice		1	8g
Double baked bread	medium	1	110g
Pastry	small	1	30g
Biscuit – lemon puff		1	18g
Biscuit - Gem		4	3g
Biscuit – Ginger		1	6g
Rice vegetable fried	cup	1	104g
Pittu	cup	1	65g
Milk Rice -	cup	1	120g
Pastry - fish	medium	1	30g
Parata	medium	1	20g
Pâtés	medium		

Food Item	Usual measurement		In g or ml
Itli	medium	1	20g
Wada	medium	1	30g
Boondi	tablespoon	1	13g
Toffee - fruit		1	3g
Toffee – Hacks		1	4g
Toffee - Milady		1	4g
Toffee – Delta		1	4g
Popcorn	small pack	1	20g
Murukku	small pack	1	31g
Murukku	tablespoon	1	9g
Cutlet	small ball	1	20g
Beverages			
Tea	cup	1	140ml
King coconut	small fruit	1	280ml
Young coconut	small fruit	1	250ml
Saruwath (a fruit drink)	cup	1	140ml
Herbal Kanji	cup	1	140ml
Lime Juice	cup	1	140ml
Coffee	cup	1	140ml
Rice Kanji	cup	1	140ml
Soft drinks – Tang	buddy bottle	1	250ml
Soft drinks – Fanta	buddy bottle	1	250ml
Orange juice	cup	1	140ml
Soup – Vegetable	cup	1	140ml
Rasam	tablespoon	1	7g
Coriander	cup	1	140ml
Mango Juice	cup	1	140ml
Apple Juice	cup	1	140ml
Soft drinks – Portello	buddy bottle	1	250ml
Avocado juice	cup	1	140ml
Milo	1 pack	1	180ml
Beli mal (Bael flower)	cup	1	140ml
Passion fruit juice	cup	1	140ml
Papaw fruit juice	cup	1	140ml
Wood apple Fruit Juice	cup	1	140ml
Gotukola (Centella) kanji	cup	1	140ml
Coconut milk kanji	cup	1	140ml
Barley water	cup	1	140ml

Appendix B
Conversion factors used to convert the weight of raw food in to cooked food

Food items	Processing types					
	Boiling		Frying		Tempering	
	X	±	X	±	X	±
Cow pea	2.23	0.01	-	-	-	-
Dhal (red)	2.20	0.01	-	-	-	-
Dhal (yellow)	2.17	0.02	-	-	-	-
Gram dhal	2.00	0.01	-	-	-	-
Green gram	2.20	0.02	-	-	-	-
Soya meat	2.43	0.02	-	-	-	-
Samba rice	2.82	0.01	-	-	-	-
Red raw rice	3.03	0.01	-	-	-	-
White raw rice	3.10	0.01	-	-	-	-
Red rice	3.52	0.03	-	-	-	-
Basmati rice	2.87	0.01	-	-	-	-
Parboiled rice	2.79	0.02	-	-	-	-
Geeni samba rice	3.31	0.02	-	-	-	-
Maggie noodles	2.66	0.02	-	-	-	-
Prima noodles	2.57	0.01	-	-	-	-
Beet root	0.97	0.01	-	-	0.52	0.03
Carrot	0.94	0.06	-	-	-	-
Brinjal	0.86	0.01	0.44	0.01	0.63	0.02
Okra	0.84	0.01	0.47	0.02	0.52	0.01
Egg plant	0.83	0.02	0.43	0.01	0.58	0.01
Potato – with peel	0.98	0.01	-	-	-	-
- without peel	1.00	0.01	0.54		0.82	0.01
Pumpkin	0.91	0.03	-	-	-	-
Spinach	0.96	-	-	-	0.78	0.01
Cabbage	0.98	-	-	-	-	-
Mukunnuwena leaves	0.97	-	-	-	0.76	-
Beans	2.50	-	-	-	-	-
Mushrooms	1.75	-	-	-	-	-
Snake gourd	0.83	-	-	-	-	-
Manioc	0.81	-	0.41	0.02	-	-
Green peas	0.89	0.01	-	-	-	-
Bread fruits	0.86	-	-	-	-	-
Root vegetables	0.85	0.05	-	-	-	-
Leafy vegetables	0.95	0.03	-	-	-	-
Egg – with shell	1.01	0.01	--		-	-
- without shell	0.91	0.03			-	-
Beef	0.61	-	-	-	-	-
Meat ball	0.87	0.02	-	-	-	-
Crab – with shell	0.96	0.04	-	-	-	-
- without shell	0.25	0.02	-	-	-	-
Shrimp – with shell	0.95	0.02	0.38	0.02	-	-
- without shell	0.48	0.02	-	-	-	-
Chicken – with skin	0.40	0.03	-	-	-	-
- without skin	0.36	0.01	-	-	-	-
Chicken – with bone	0.73	0.01	0.67	0.01	-	-
- without bone	0.36	0.01	-	-	-	-
Sausage	-	-	0.80	0.02	-	-
Sprat	-	-	0.72	0.02	-	-
Sardinella fish –						
- with spine	0.84	0.01	0.63	0.01	-	-
- without spine	0.74	0.02	-	-	-	-
Thilapia fish–						
-with spine	0.86	0.02	0.64	0.02	-	-
-without spine	0.72	0.01	-	-	-	-
Trenched sardine fish –	0.83	0.02	-	-	-	-

-with spine	-	-	-	-	-	-
-without spine						
Tuna – with spine	0.80	-	-	-	-	-
- without spine	0.63	0.01	-	-	-	-
Carp – with spine	0.88	0.03	-	-	-	-
- without spine	0.62	0.03	-	-	-	-

X= mean value of data - = data unavailable ±= confidence interval