



HAL
open science

Infant feeding patterns and cardiovascular risk factors in young adulthood; data from five cohorts in low and middle income countries

Chd Fall, Judith Borja, Clive Osmond, Linda Richter, Santosh Bhargava, Reynaldo Martorell, Aryeh D Stein

► To cite this version:

Chd Fall, Judith Borja, Clive Osmond, Linda Richter, Santosh Bhargava, et al.. Infant feeding patterns and cardiovascular risk factors in young adulthood; data from five cohorts in low and middle income countries. *International Journal of Epidemiology*, 2010, 10.1093/ije/DYQ155 . hal-00624429

HAL Id: hal-00624429

<https://hal.science/hal-00624429>

Submitted on 17 Sep 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

**Infant feeding patterns and cardiovascular risk factors in
young adulthood;
data from five cohorts in low and middle income countries**

Journal:	<i>International Journal of Epidemiology</i>
Manuscript ID:	IJE-2010-01-0018.R2
Manuscript Type:	Original Article
Date Submitted by the Author:	19-Jul-2010
Complete List of Authors:	Fall, CHD; MRC Epidemiology Resource Centre, University of Southampton Borja, Judith; Office of Population Studies Foundation, University of San Carlos Osmond, Clive; MRc Environmental Epidemiology Unit, University of Southampton Richter, Linda; Human Sciences Research Council Bhargava, Santosh; Sunder Lal Jain Hospital Martorell, Reynaldo; Hubert Dept of Global Health, Emory University Stein, Aryeh; Emory University, Hubert Department of Global Health
Key Words:	Infant feeding, Breastfeeding, Complementary feeding, Blood pressure, Diabetes, Body composition

1
2
3 **Infant feeding patterns and cardiovascular risk factors in young adulthood;**
4 **data from five cohorts in low and middle income countries**
5
6
7

8
9 **Caroline HD Fall, Judith B Borja, Clive Osmond, Linda Richter, Santosh K Bhargava,**
10 **Reynaldo Martorell, Aryeh D Stein, Fernando C Barros, Cesar G Victora, and the**
11 **COHORTS group**
12

13
14
15 MRC Epidemiology Resource Centre, University of Southampton, Southampton General
16 Hospital, Southampton, UK (CHDF, CO); Office of Population Studies Foundation,
17 University of San Carlos, Cebu City, Philippines (JBB); Human Sciences Research Council,
18 University of Witwatersrand, South Africa (LR); Sunder Lal Jain Hospital, New Delhi, India
19 (SKB); Hubert Department of Global Health, Rollins School of Public Health, Emory
20 University, Atlanta, USA (ADS, RM); Universidade Catolica de Pelotas, Brazil (FCB);
21 Universidade Federal de Pelotas, Brazil (CGV).
22
23
24
25
26
27
28

29 Author for correspondence and reprint requests: Professor Caroline Fall, MRC Epidemiology
30 Resource Centre, University of Southampton, Southampton General Hospital, Tremona Road,
31 Southampton SO16 6YD, UK. Tel: 00 44 2380 777624; Fax: 00 44 2380 704021; e-mail
32 chdf@mrc.soton.ac.uk
33
34
35
36
37
38
39

40 **Word count:** Abstract: 258; Text: 3,701; Tables 5, Figures 2; Online supplementary tables 8,
41 figures 5.
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 **1 ABSTRACT**
4

5 **2 Background** Infant feeding patterns may influence lifelong health. This study tested the
6
7
8 hypothesis that longer duration of breastfeeding and later introduction of complementary
9
10 foods in infancy are associated with reduced adult cardiovascular risk.
11

12 **5 Methods** Data were pooled from 10,912 subjects aged 15-41 years from five prospective
13
14 birth cohort studies in low/middle-income countries (Brazil, Guatemala, India, Philippines,
15
16 South Africa). Associations were examined between infant feeding (duration of breastfeeding
17
18 and age at introduction of complementary foods) and adult blood pressure, plasma glucose
19
20 concentration, and adiposity (skinfolds, waist circumference, percentage body fat,
21
22 overweight/obesity). Analyses were adjusted for maternal socio-economic status, education,
23
24 age, smoking, race and urban/rural residence, and infant birthweight.
25
26
27
28

29 **12 Results** There were no differences in outcomes between adults who were ever breastfed
30
31 compared with those who were never breastfed. Duration of breastfeeding was not associated
32
33 with adult diabetes prevalence or adiposity. There were U-shaped associations between
34
35 duration of breastfeeding and systolic blood pressure and hypertension; however these were
36
37 weak and inconsistent among the cohorts. Later introduction of complementary foods was
38
39 associated with lower adult adiposity. BMI changed by -0.19 kg/m^2 (95%CI $-0.37,-0.01$) and
40
41 waist circumference by -0.45 cm (95% CI $-0.88,-0.02$) per 3-month increase in age at
42
43 introduction of complementary foods.
44
45
46
47

48 **20 Conclusions** There was no evidence that longer duration of breastfeeding is protective
49
50 against adult hypertension, diabetes or overweight/adiposity in these low/middle-income
51
52 populations. Further research is required to determine whether *exclusive* breastfeeding may be
53
54 protective. Delaying complementary foods until 6 months, as recommended by WHO, may
55
56 reduce the risk of adult overweight/adiposity, but the effect is likely to be small.
57
58
59
60

25

1
2
3 1 **Keywords:** Infant feeding, breastfeeding, complementary feeding, blood pressure, diabetes,
4
5 2 body composition.
6
7
8 3
9

10 4 **INTRODUCTION**
11
12 5

13
14
15 6 The World Health Organisation recommends exclusive breastfeeding from birth to 6 months,
16
17 7 the introduction of nutritious complementary foods at 6 months, and continued breastfeeding
18
19 8 for ≥ 2 years (1). Breastfeeding reduces morbidity and mortality from infection during infancy,
20
21 9 and the timely introduction of nutritious complementary foods prevents stunting (2,3).
22
23

24
25 10 Optimal infant feeding may also have long-term benefits. Adults and children who were
26
27 11 breastfed have lower blood pressure, and lower rates of obesity and type 2 diabetes than those
28
29 12 who were bottle-fed (4-8), with benefit proportionate to the duration of breastfeeding (9-14).
30
31 13 This has been attributed to better appetite regulation and/or lower weight gain in breastfed
32
33 14 infants, and/or effects of nutrients or bioactive constituents in breastmilk (6). Fewer studies
34
35 15 have investigated long-term associations with the timing of initiation of complementary
36
37 16 feeding, but lower rates of childhood obesity have been reported among those who started
38
39 17 complementary foods later (15-17).
40
41
42
43
44
45

46 19 A limitation of the published evidence linking breastfeeding to later health is reliance on
47
48 20 maternal recall of infant feeding practices, sometimes many years later (6-14). Few studies
49
50 21 had data on duration of breastfeeding, and almost none had information on complementary
51
52 22 feeding. The majority were conducted in high-income countries, where mothers who follow
53
54 23 prescribed infant feeding guidelines tend to be from higher socio-economic and more
55
56 24 educated groups (18,19). Associations of infant feeding with later adiposity and other risk
57
58 25 factors are usually attenuated after adjusting for these confounding factors, suggesting that
59
60

1 generally healthier family lifestyles, rather than infant feeding, explain the lower disease risk.

2

3 In low- and middle-income countries (LMICs), breastfeeding tends to be the norm, but many

4 mothers introduce complementary foods and stop breastfeeding too early (2). Obesity,

5 diabetes and cardiovascular disease are rising rapidly in these countries (20). Promoting

6 optimal infant feeding practices could be a low-cost intervention to improve lifelong health.

7 Data from LMICs may help address confounding issues, because relationships between infant

8 feeding practices and social class differ from those in high-income settings. The current study

9 analyses data from the COHORTS collaboration (Consortium on Health Orientated Research

10 in Transitional Societies) (21) comprising birth cohort studies in five LMICs. Our objective

11 was to test the hypothesis that initial breastfeeding, longer duration of breastfeeding and later

12 introduction of complementary foods are associated with lower adult blood pressure, glucose

13 concentrations and adiposity.

14

15 **SUBJECTS AND METHODS**

16

17 *Description of the cohorts*

18

19 The collaboration among the five cohorts (Table 1) was originally established to contribute a

20 paper for a Lancet series on Maternal and Child Nutrition (22). One author (CGV)

21 approached the principal investigators of all follow-up studies in LMICs with ≥ 1000 subjects

22 aged ≥ 15 years; all agreed to participate. The cohorts include the 1982 Pelotas (Brazil) Birth

23 Cohort (23); the Institute of Nutrition of Central America and Panama Nutrition Trial Cohort

24 (INTCS, Guatemala) (24); the New Delhi (India) Birth Cohort Study (25); the Cebu

25 (Philippines) Longitudinal Health and Nutrition Survey (CLHNS) (26) and the Birth to

1
2
3 1 Twenty (BTT - South Africa) cohort (27). The Guatemala cohort was based on a randomised
4
5 2 controlled trial of protein-energy supplementation for the pregnant mothers of the cohort
6
7 3 members, and for the cohort themselves as young children (24); the others were observational
8
9 4 studies. All studies were approved by institutional research ethics committees, and
10
11 5 participants gave informed consent.
12
13 6
14

15 6 16 17 7 *Feeding data* 18

19 8
20
21 9 The methods used to collect infant feeding data varied among the cohorts (Table 1). We
22
23 10 defined complementary foods as semi-solid or solid foods. Variables used in the analysis were
24
25 11 1) whether an individual was ever breast fed (yes/no), available for all 5 cohorts, 2) total
26
27 12 duration of breast feeding (9 categories from 0 to >24 months), available for all cohorts
28
29 13 except India and 3) age at which complementary feeds were introduced (6 categories from <3
30
31 14 to >18 months), available for all cohorts except Guatemala.
32
33
34
35
36
37
38

39 16 *Adult outcomes* 40

41 17
42
43 18 Except for the South African participants who were adolescents (mean age 15 years) all others
44
45 19 were young adults. For simplicity, these measures are referred to as “adult” outcomes.
46
47
48
49

50 21 Systolic (SBP) and diastolic (DBP) blood pressures were measured by aneroid
51
52 22 sphygmomanometer in Brazil, mercury sphygmomanometer in the Philippines, and digital
53
54 23 devices elsewhere (Guatemala: UA-767, A&D Medical; India: Omron 711; South Africa:
55
56 24 Omron M6), using appropriate cuff sizes, after 5-10 minutes seated. The average of two or
57
58 25 three measurements was used (21). Hypertension was defined as SBP \geq 140 or DBP \geq 90
59
60

1 mmHg and pre-hypertension as SBP ≥ 130 or DBP ≥ 80 . In South Africa we defined pre-hypertension as SBP or DBP ≥ 90 th percentile of age-, sex- and height-specific cut points (28). Across all cohorts, less than 0.5% of participants were on anti-hypertensive medication.

4
5 Fasting glucose concentrations were measured in venous plasma (India and South Africa) or capillary plasma (Guatemala) using standard laboratory enzymatic methods, and in venous whole blood (Philippines) using a glucometer ('One Touch', Johnson & Johnson Ltd). In Brazil, random finger-prick capillary whole blood glucose was measured by glucometer (Accu-Check Advantage, Roche Ltd); values were adjusted for time since the last meal (29). Glucometers over-estimate glucose concentrations in whole venous blood compared with standard laboratory methods (30,31); we subtracted 0.97 mmol/l from the Philippine values (30). Diabetes was defined as a glucose concentration ≥ 7.0 mmol/l, and impaired fasting glucose (IFG) as a concentration ≥ 6.1 mmol/l and < 7.0 mmol/l (32).

15 Body composition outcomes included body mass index (BMI, weight/height²), waist circumference, body fat percentage, triceps and subscapular skinfolds, overweight (BMI ≥ 25 kg/m²) and obesity (BMI ≥ 30 kg/m²) (33). Percentage body fat was estimated in Brazil using bioimpedance and a deuterium-validated equation (34); in Guatemala using weight, height and waist circumference with an equation developed using hydrostatic weighing (35); in India and the Philippines using skinfold equations validated for Asian populations (36,37); and in South Africa using dual-energy X-ray absorptiometry (Hologic Delphi).

23 *Confounding variables*

25 Earlier research in these cohorts (38-42) indicated that the following should be considered as

1 possible confounding factors: maternal socio-economic status (SES), education, age,
2 smoking, rural/urban residence and race, and infant birth weight. For SES at birth, a 5-level
3 variable was created for each cohort (1=least and 5=most advantaged), using a principle
4 components analysis of household income and/or assets and services (Brazil, Guatemala,
5 Philippines, South Africa) or the father's occupation (India). Information on maternal
6 smoking was not available for Guatemala and India, where maternal smoking was almost
7 non-existent at that time; we assumed all were non-smokers. Brazil and South Africa had
8 racial/skin colour sub-groups; we created variables for white, black, mixed race and Asian
9 groups. The Brazil, India and South Africa cohorts are urban, and the Guatemala cohort rural;
10 in the mixed rural and urban Philippine cohort, an 'urbanicity index' was used (43).

12 *Missing data and final analysis sample*

14 There was minimal missing data in Brazil, the Philippines and South Africa (Table 2). In the
15 Guatemala cohort, age of introduction of complementary foods was not recorded, and
16 duration of breastfeeding was missing for 48% of participants. Missing data arose from the
17 study design; recruitment included pregnant women and children ≤ 7 years at baseline; infant
18 feeding was not recorded for children >15 months old at recruitment. Participants with
19 missing data were older, more adipose and more likely to have diabetes or hypertension. In
20 India, duration of breastfeeding was not recorded, and age of introduction of complementary
21 foods was missing for 61% of participants. Those with missing data were younger and less
22 adipose.

24 The analysis sample (N=10,912) included participants with data on at least one of the three
25 infant feeding variables and at least one adult outcome (blood pressure, glucose concentration,

1 body composition), and excluded women who were pregnant at the time of the outcome
2 measurements.

3

4 *Statistical methods*

5

6 Variables with skewed distributions were log transformed (glucose concentrations, skinfolds).

7 Associations among feeding variables, potential confounders and adult outcomes were

8 assessed within each cohort and in pooled data, using linear or logistic regression or Chi

9 square tests. Categorized duration of breastfeeding and age at introduction of complementary

10 foods were treated as continuous variables in linear regression models, and non-linear

11 associations were tested using quadratic terms. Models were initially adjusted for age and sex

12 only, and then for the set of confounding variables, adult BMI (not done for the adiposity

13 outcomes) and height. Parameter estimates given in the text are fully adjusted. All pooled

14 models were adjusted for cohort location and included interaction terms between cohort

15 location and each confounding variable. We tested for heterogeneity of associations across the

16 five sites by using (for continuous variables) F-tests from nested linear regression models and

17 (for binary outcomes) Chi square tests based on the difference in deviance between nested

18 models; where there was significant heterogeneity ($p < 0.05$), we present data separately for

19 each site. Sex differences were tested using interaction terms.

20

21 **RESULTS**

22

23 The number of participants included in this analysis, as a percentage of the original live births

24 in each cohort, ranged from 19% in India to 75% in Brazil (Table 1). More than 90% of

25 babies in all cohorts were initially breastfed (Table 2). The most frequent duration of

1
2
3 1 breastfeeding was 1-3 months in Brazil, 12-18 months in Guatemala and the Philippines, and
4
5 2 >2 years in South Africa, and the most frequent age at introduction of complementary foods
6
7 3 was 0-3 months in Brazil and South Africa, 3-6 months in the Philippines, and 9-12 months in
8
9 4 India.

10 5 11 12 13 14 15 6 *Predictors of infant feeding variables*

16
17 7
18 8 Associations between the confounding variables and infant feeding variables are presented in
19
20 9 additional online material Tables A-G. To summarise these data: in Brazil, women of lower
21
22 10 SES/education were less likely to initiate breastfeeding, and tended to breastfeed for either a
23
24 11 short or long duration (Tables A&B). In the Philippines and South Africa, women of lower
25
26 12 SES/education were more likely to initiate breastfeeding and breastfed for longer. In Brazil,
27
28 13 India and the Philippines, more affluent/educated mothers introduced complementary foods
29
30 14 earlier. In Brazil and Guatemala women who breastfed for longer tended to be older (Table
31
32 15 C). In Brazil and South Africa mothers who smoked (35% and 6% respectively) stopped
33
34 16 breastfeeding earlier; the opposite association was seen in the Philippines (13%) (Table D). In
35
36 17 Brazil and South Africa there were racial differences in feeding patterns (Table E). In the
37
38 18 Philippines, rural mothers were more likely to initiate breastfeeding, breastfed for longer, and
39
40 19 introduced complementary foods later (Table F). Babies who were breastfed for a shorter
41
42 20 duration tended to have lower birthweight in all cohorts (Table G); in Brazil and India, babies
43
44 21 who started complementary foods earlier had higher birthweight.

45
46
47 22
48
49 23 Mean age at adult follow-up ranged from 16 years (South Africa) to 32 years (Guatemala)
50
51 24 (Table 3). The prevalence of hypertension ranged from 1% (Philippines, females) to 17%
52
53 25 (Brazil, males), of diabetes from <1% (Philippines and South Africa) to 4% (Brazil and India,
54
55 26 males) and of obesity from 1% (Philippines, females) to 25% (Guatemala, females).

1

2 *Ever v never breastfed*

3

4 In the pooled data, there were no differences in blood pressure, glucose or body composition
5 outcomes between participants who were initially breastfed compared with those not
6 breastfed (Tables 4&5). There was heterogeneity between sites for diastolic blood pressure
7 (Table 4); in Brazil DBP was lower among participants who were breastfed (-1.5 mmHg, 95%
8 CI -2.7,-0.3), while in the Philippines and South Africa there was a trend in the opposite
9 direction (Philippines: +1.3 mmHg, 95% CI -0.5,3.1; South Africa: +1.4 mmHg, 95% CI
10 0.6,2.2). There was also heterogeneity between sites for prevalence of overweight (Table 5),
11 with a lower risk in Brazil among participants who were breastfed (OR 0.76, 95% CI 0.59 to
12 0.98), and opposite trends in the Philippines (OR 1.4, 95% CI 0.4 to 2.8) and South Africa
13 (OR 1.4, 95% CI 0.5 to 4.2).

14

15 *Breastfeeding duration*

16

17 In the pooled data, there were U-shaped associations between breastfeeding duration and all
18 the blood pressure outcomes (Table 4, Figure 1). For SBP and hypertension, these remained
19 after adjustment for confounding factors, adult BMI and height. The lowest mean blood
20 pressures were observed among participants who had been breastfed for 3-6 months; there
21 was a difference of approximately 2 mmHg between the lowest and highest mean values
22 (Figure 1). Several of these U-shaped associations showed borderline heterogeneity across the
23 cohorts (Table 4). A U-shaped association was clear only in Brazil (Figure 1); there was an
24 upward trend in Guatemala, and no apparent trends with duration of breastfeeding in the
25 Philippines and South Africa. After excluding the Brazil data, there were no linear or U-

1 shaped associations between breastfeeding duration and any blood pressure outcome.

2
3 There was no heterogeneity among the cohorts for glucose or body composition outcomes.

4 There was a U-shaped association between breastfeeding duration and IFG+DM (Table 4),
5 and an inverse association between breastfeeding duration and adult skinfold thickness (Table
6 5). However, these associations were attenuated after adjusting for confounding variables.

7
8 There were no changes in the findings if the Guatemala cohort, in which duration of
9 breastfeeding was missing for 48% of participants, was excluded from the analysis. In the
10 Guatemala data, there was an interaction between intervention group and duration of
11 breastfeeding for only one outcome (adult BMI); there were no changes in the findings when
12 the two intervention groups were considered as separate populations.

13 14 *Introduction of complementary foods*

15
16 The age at introduction of complementary foods was unrelated to the blood pressure and
17 glucose outcomes (Table 4). There was no significant heterogeneity among the cohorts.
18 Later introduction of complementary foods was associated with lower adult BMI, waist
19 circumference and percentage body fat, thinner skinfolds, and a lower risk of
20 overweight/obesity (Table 5, Figure 2). The findings were similar after excluding the India
21 cohort, which had a higher mean age at introduction of complementary foods, and in which
22 data were missing for 61% of participants. Inverse associations were still present for BMI,
23 waist circumference and subscapular skinfolds, which fell by 0.19 kg/m² (95% CI 0.01,0.37),
24 0.45 cm (95% CI 0.02,0.88), and 3.1% (95% CI 0.6,5.4; the percentage change in skinfolds is
25 cited here rather than the change in mm, because the skinfold values were logged for analysis

1) respectively per category increase in age of introduction of complementary foods. When the
2 analysis was limited to the period up to 6 post-natal months, these associations were
3 attenuated; BMI, waist circumference and subscapular skinfold thickness fell by 0.21 (95% CI
4 -0.03 0.45), 0.45 cm (95% CI -0.11, 1.01) and 2.6% (95% CI -0.9, 6.1) respectively per 3-
5 month category.

6
7 Earlier introduction of complementary foods was associated with higher infant weight at 2
8 years (additional online material Table H). After adjusting for 2-year weight, the inverse
9 associations between age of introduction of complementary feeds and adult adiposity were no
10 longer present.

11
12 There was no consistent evidence of differences according to sex, or the age at which
13 outcomes were measured, in any of the associations described.

14
15 Associations of duration of breastfeeding and age of introduction of complementary foods
16 with selected outcomes are presented by individual cohort in additional online material
17 Figures J-N.

18 19 **DISCUSSION**

20
21 We combined data from five birth cohorts in low- and middle-income countries, to examine
22 associations between infant feeding and risk factors for cardiovascular disease (blood
23 pressure, glucose concentrations and adiposity) in over 10,000 young adults. There were no
24 differences in risk factors between participants who were initially breastfed compared to those
25 who were never breastfed. There were U-shaped associations between duration of

1
2
3 1 breastfeeding and adult blood pressure, with the lowest mean systolic blood pressure among
4
5 2 those breastfed for 3-6 months; however these were small and inconsistent effects. After
6
7 3 adjusting for confounding factors, there were no associations between duration of
8
9 4 breastfeeding and adult glucose concentrations, DM+IFG or body composition. Participants
10
11 5 who started complementary foods later in infancy were less adipose and overweight in adult
12
13 6 life. These associations were robust to adjustment for the set of confounding variables, but
14
15 7 attenuated by adjustment for 2-year weight.
16
17
18
19
20
21

22 9 Strengths of the study were that infant feeding data were collected prospectively, reducing the
23
24 10 risk of misclassification due to inaccurate maternal recall, and included duration of
25
26 11 breastfeeding and introduction of complementary foods. Limitations were missing infant
27
28 12 feeding data and losses to follow-up in the older Guatemala and India cohorts. Missing data
29
30 13 would influence population means and prevalence values for both exposures and outcomes,
31
32 14 but the within-cohort associations of interest, between infant feeding and adult outcomes,
33
34 15 would be less vulnerable to bias. Associations of duration of breastfeeding and age of
35
36 16 introduction of complementary foods were little changed if the Guatemala and India cohorts
37
38 17 were excluded from the relevant analyses. A further limitation of the study was heterogeneity
39
40 18 among the cohorts in the methods for recording infant feeding data. This reduced the number
41
42 19 of exposures we could include (for example, exclusive breastfeeding and predominant
43
44 20 breastfeeding were definable in only 1 and 3 of the cohorts respectively and were not
45
46 21 included), and we defined introduction of complementary feeds as the introduction of solids
47
48 22 rather than nutritious liquids and solids, the more generally used definition. The different
49
50 23 methods would tend to reduce the precision of the exposure variables and thus attenuate any
51
52 24 estimates of association with adult outcomes. The methods used for measuring adult
53
54 25 outcomes also varied among the cohorts, although are all accepted techniques for
55
56
57
58
59
60

1 epidemiological studies. Blood pressure was measured using a variety of devices, all of which
2 perform to international standards, although systematic under- or over-estimation of blood
3 pressure is recognised (44-47). Blood glucose was measured using standard laboratory assays
4 or by glucometers, and although the latter are not recommended for clinical diagnosis of
5 individual patients, their use in epidemiological studies is accepted (48). Four studies
6 measured fasting glucose; the Pelotas study used random glucose, adjusted for time since the
7 last meal (29). Adiposity was measured using similar anthropometric protocols in all studies,
8 and percentage body fat was measured using a variety of techniques that have been validated
9 in appropriate populations. Different techniques would influence the precision of
10 measurements, which could obscure associations but is unlikely to create spurious
11 associations. Systematic over-/under- estimation of (say) blood pressure or the prevalence of
12 hypertension would not affect the ranking of the participants, and would not, therefore,
13 substantially change the associations of interest.

14
15 A consistent finding was that later introduction of complementary foods was associated with
16 lower adult adiposity. Previous literature on this topic is mixed; some studies have reported
17 findings similar to ours (15-17). Others have reported no association (4,49,50) or an opposite
18 association (51). In our pooled data there was a linear decrease in adult adiposity across the
19 range of ages at which complementary foods were started (<3 months to >18 months) (Figure
20 2). Introduction of complementary foods later than 6 months is associated with nutritional
21 inadequacy and growth faltering (1,2) and cannot be recommended. However, in our data,
22 there was a downward trend in adiposity with later introduction of complementary foods even
23 in the first 6 post-natal months (Figure 2), though this was very small and likely to be of
24 limited health significance. Earlier introduction of complementary foods is associated with
25 greater infant weight gain (52), and our results, showing no association after adjusting for 2-

1
2
3 1 year weight, suggest that this could be a mediating factor.
4
5
6 2

7
8 3 There were no differences in outcomes between 'ever' versus 'never' breastfed groups. This
9
10 4 contrasts with results from meta-analyses of observational studies, mainly in high-income
11
12 5 settings, which have shown lower systolic (around -1 mmHg) and diastolic blood pressure (<-
13
14 6 0.5 mmHg), a 30-40% lower risk of type 2 diabetes and a 20% lower risk of overweight or
15
16 7 obesity in children or adults who were breastfed (6-9). Possible explanations for our negative
17
18 8 findings are that initiation of breastfeeding was almost universal in these cohorts (hence
19
20 9 reducing power), and/or that the associations in the above studies result from residual
21
22 10 confounding, not seen in our cohorts because of the different relationships between infant
23
24 11 feeding and maternal SES.
25
26
27
28
29
30
31
32
33

34 13 There were U-shaped associations between duration of breastfeeding and blood pressure
35
36 14 outcomes. These trends were inconsistent among the 5 cohorts (Figure 1). Overall, there was
37
38 15 no evidence that longer duration of breastfeeding protects against the later development of
39
40 16 hypertension or diabetes. Again, these findings differ from those reported from high-income
41
42 17 settings, where most studies (9,10,12,53,54), though not all (55,56), found lower blood
43
44 18 pressure and/or a lower risk of type 2 diabetes in children or adults who were breastfed for
45
46 19 longer. Explanations could be, again, residual confounding in high-income populations;
47
48 20 imprecision in the exposure measure due to different data collection methods; or differences
49
50 21 in other post-natal factors related to the adult outcomes, for example childhood growth,
51
52 22 between low- and high-income populations.
53
54
55
56
57
58
59
60

60 24 A recent systematic review of studies in children and adults found a linear inverse association
25
between duration of breastfeeding and risk of overweight/obesity in about half the studies

1 (14). The associations were diminished after adjusting for confounders, but remained in some
2 studies. We found that participants who were breastfed for longer in infancy had thinner
3 skinfolds, but the associations were attenuated by adjusting for confounding variables.
4 Confounding has been a major limitation of studies linking infant feeding to later health. The
5 ultimate solution to this problem would be randomised controlled trials, but it is not possible
6 to randomize healthy babies into breastfed and non-breastfed groups. Helpful data will come
7 from a large randomised trial of breastfeeding promotion, in Belarus, which greatly increased
8 initiation rates and duration of breastfeeding (57). In this trial, there were no differences in
9 blood pressure or adiposity between children from the intervention and control groups at 9
10 years. In another trial, among pre-term newborns, there was no difference in blood pressure in
11 childhood between those randomised to receive breast milk or formula (58), but blood
12 pressure was lower in the breast milk group in adolescence (59). We know of no randomised
13 trials of early versus late introduction of complementary foods.

14
15 In conclusion, in 5 high-quality birth cohorts in low- and middle-countries, we found no
16 evidence that initial breastfeeding, or longer duration of breastfeeding, were protective against
17 adult hypertension, diabetes or overweight/obesity. There are many proven benefits of
18 breastfeeding, but the evidence that it reduces the risk of adult chronic disease is not
19 compelling, at least in LMICs. We were not, however, able to examine *exclusive*
20 *breastfeeding* as an exposure, since this was available for only one of the cohorts. There was a
21 consistent linear inverse association between age of introduction of complementary foods and
22 adult adiposity. Our data suggest there may be modest protection against adult adiposity from
23 delaying the introduction of complementary foods to the recommended 6 months. This
24 association should be examined in other studies.

1 **Funding support:** The COHORTS collaboration is funded by the Wellcome Trust, UK.
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 **Funding support:** The COHORTS collaboration is funded by the Wellcome Trust, UK.
2 Funding sources for each of the COHORTS sites are as follows: Brazil: Wellcome Trust.
3 Guatemala: US National Institutes of Health, US National Science Foundation, Nestle
4 Foundation, Thrasher Foundation and American Heart Association. India: US National Center
5 for Health Statistics, Indian Council of Medical Research, British Heart Foundation, Medical
6 Research Council UK. The Philippines: US National Institutes of Health, Fogarty
7 International Center. South Africa: Wellcome Trust, Human Sciences Research Council,
8 South African Medical Research Council, Mellon Foundation, South-African Netherlands
9 Programme on Alternative Development and the Anglo American Chairman's Fund. All
10 authors/researchers are independent of the funding bodies.

11
12 ***COHORTS group members not included as named authors for this paper:**
13 Denise Gigante, Pedro Hallal and Bernardo Horta (Universidade Federal de Pelotas, Brazil),
14 Manuel Ramirez-Zea (Institute of Nutrition of Central America and Panama, Guatemala City,
15 Guatemala), Andrew Wills (MRC Epidemiology Resource Centre, University of
16 Southampton, Southampton, UK), Harshpal Singh Sachdev (Sitaram Bhartia Institute of
17 Science and Research, New Delhi, India), Linda Adair (University of North Carolina at
18 Chapel Hill, Chapel Hill, USA), Darren Dahly (University of Leeds, UK), Christopher
19 Kuzawa (Department of Anthropology, Northwestern University, Illinois, USA), Shane
20 Norris, Daniel Lopez and Mathew Mainwaring (Department of Paediatrics, MRC Mineral
21 Metabolism Research Unit, University of the Witwatersrand, Johannesburg, Bt20).

22
23 Special thanks to other major contributors to the 5 studies: **Brazil:** Rosangela Lima
24 (Universidade Católica de Pelotas); **India:** Lakshmi Ramakrishnan, Nikhil Tandon (All-India
25 Institute of Medical Sciences, New Delhi), Dorairaj Prabhakaran (Centre for the Control of

1
2
3 1 Chronic Diseases, New Delhi), Siddharth Ramji (Maulana Azad Medical College, New
4
5
6 2 Delhi), K Srinath Reddy (Public Health Foundation of India); SK Dey Biswas (Indian Council
7
8 3 of Medical Research); Vinod Kapani (Bureau of Labor Statistics, Washington DC, USA);
9
10 4 **Guatemala:** Ann DiGirolamo Rafael Flores (US Centers for Disease Control), Usha
11
12 5 Ramakrishnan, Kathryn Yount (Emory University), Ruben Grajeda (PAHO), Paul Melgar,
13
14 6 Humberto Mendez, Luis Fernando Ramirez (INCAP), Jere Behrman (University of
15
16 7 Pennsylvania), John Hoddinott, Agnes Quisumbing, Alexis Murphy (IFPRI), John Maluccio
17
18 8 (Middlebury College); **Philippines:** Barry Popkin (University of North Carolina at Chapel
19
20 9 Hill), Sororro Gultiano, Josephine Avila, Lorna Perez (Office of Population Studies
21
22 10 Foundation, University of San Carlos, Cebu), Thomas McDade (Northwestern University);
23
24 11 South Africa: Noel Cameron (Loughborough University, UK), John Pettifor (University of
25
26 12 Witwatersrand). The manuscript and figures were prepared by Jane Pearce.
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

REFERENCES

1. Daelmans B, Martines J, Saadeh R (Eds). Special Issue Based on a World Health Organization Expert Consultation on Complementary Feeding. Food Nutr Bulletin 2003;24:1-134.
2. Black RE, Allen LH, Bhutta Z et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 2008;371:243-60.
3. Bhutta Z, Ahmad T, Black RE et al. What works? Interventions to affect maternal and child undernutrition and survival globally. Lancet 2008;371:417-40.
4. Kramer MS. Do breast-feeding and delayed introduction of solid foods protect against subsequent obesity? J Pediatrics 1981;98:883-887.
5. Horta BL, Bahl R, Martines JC, Victora CG. Evidence on the long-term effects of breastfeeding: systematic reviews and meta-analyses. Geneva: WHO, 2007. (ISBN 978-92-4-159523-0).
6. Owen CG, Whincup PH, Gilg JA, Cook DG. Effect of breast feeding in infancy on blood pressure in later life: systematic review and meta-analysis. BMJ 2003;327:1189-95.
7. Owen CG, Martin RM, Whincup PH, Davey Smith G, Cook DG. Does breastfeeding influence the risk of type 2 diabetes in later life? A quantitative analysis of published

- 1
2
3 evidence. *AJCN* 2006;84:1043-54.
4
5
6
7
- 8 8. Owen CG, Martin RM, Whincup PH, Davey Smith G, Cook DG. Effect of infant
9 feeding on the risk of obesity across the life course: a quantitative review of published
10 evidence. *Pediatrics* 2005;115:1367-77.
11
12
13
14
15
16
- 17 9. Taittonen L, Nuutinen M, Turtinen J, Uhari M. Prenatal and postnatal factors in
18 predicting later blood pressure among children: cardiovascular risk in young Finns.
19 *Ped Res* 1996;40:627-32.
20
21
22
23
24
25
- 26 10. Lawlor DA, Riddoch CJ, Page AS et al. Infant feeding and components of the
27 metabolic syndrome: findings from the European Youth Heart Study. *Arch Dis Child*
28 2005;90:582-8.
29
30
31
32
33
34
- 35 11. Martin RM, Ben-Shlomo Y, Gunnell D, Elwood P, Yarnell JWG, Davey Smith G.
36 Breast feeding and cardiovascular disease risk factors, incidence, and mortality: the
37 Caerphilly Study. *J Epidemiol Community Health* 2005;59:121-9.
38
39
40
41
42
43
44
- 45 12. Young TK, Martens PJ, Taback SP et al. Type 2 diabetes mellitus in children; prenatal
46 and early infancy risk factors among Native Canadians. *Arch Pediatr Adolesce Med*
47 2002;156:651-5.
48
49
50
51
52
53
- 54 13. Rich-Edwards JW, Stampfer MJ, Manson JE et al. Breastfeeding during infancy and
55 the risk of cardiovascular disease in adulthood. *Epidemiology* 2004;15:550-6.
56
57
58
59
60

- 1
2
3 14. Arenz S, Ruckerl R, Koletzko B, von Kries R. Breastfeeding and childhood obesity; a
4
5 systematic review. *Int J Obes Relat Metab Disord* 2004;28:1247-54.
6
7
8
9
- 10 15. Wilson AC, Forsyth JS, Greene SA, Irvine L, Hau C, Howie PW. Relation of infant
11
12 diet to childhood health: seven year follow up of cohort of children in Dundee infant
13
14 feeding study. *BMJ* 1998;316:21-25.
15
16
17
18
- 19 16. Reilly JJ, Armstrong J, Dorosty AR et al. Early life risk factors for obesity in
20
21 childhood: cohort study. *BMJ* 2005;330:1357.
22
23
24
25
26
- 27 17. Hawkins SS, Cole TJ, Law CM and the Millennium Cohort Study Child Health
28
29 Group. An ecological systems approach to examining risk factors for early childhood
30
31 overweight: findings from the UK Millennium Cohort Study. *J Epidemiol Community*
32
33 *Health* 2009;63:147-55.
34
35
36
37
38
- 39 18. Heck KE, Braveman P, Cubbin C, Chavez GF, Kiely JL. Socioeconomic status and
40
41 breastfeeding initiation among California mothers. *Public Health Rep* 2006;121:51-59.
42
43
44
45
- 46 19. Bolling K, Grant C, Hamlyn B. *Infant Feeding Survey 2005*. London: The Information
47
48 Centre, 2007.
49
50
51
- 52 20. Fall CHD. Non-industrialised countries and affluence. In *Type 2 Diabetes: the thrifty*
53
54 *phenotype*. Ed DJP Barker. *Brit Med Bull* 2001;60:33-50.
55
56
57
58
- 59 21. Adair LS, Martorell R, Stein AD et al. Size at birth, weight gain in infancy and
60

1
2
3 childhood and adult blood pressure in five low and middle income country cohorts:

4
5 When does weight gain matter? *AJCN* 2009;89:1383-92.
6
7

8
9
10 22. Victora CG, Adair L, **Fall C**, Hallal PC, Martorell R, Richter L, Sachdev HPS and the
11
12 Maternal and Child Undernutrition Study Group. Maternal and child undernutrition:
13
14 consequences for adult health and human capital. *Lancet* 2008; 371: 340-357.
15
16

17
18
19 23. Victora CG, Barros FC. Cohort profile: the 1982 Pelotas (Brazil) birth cohort study.
20
21
22 Int J Epidemiol 2006;35:237-42.
23
24

25
26
27 24. Stein AD, Melgar P, Hoddinott J, Martorell R. Cohort Profile: the Institute of
28
29 Nutrition of Central America and Panama (INCAP) Nutrition Trial Cohort Study. *Int J*
30
31 Epidemiol 2008;37:716-20.
32
33

34
35
36 25. Bhargava SK, Sachdev HS, Fall CH, et al. Relation of serial changes in childhood
37
38 body-mass index to impaired glucose tolerance in young adulthood. *N Engl J Med*
39
40 2004;350:865-75.
41
42

43
44
45 26. Adair LS. Size at birth and growth trajectories to young adulthood. *Am J Hum Biol*
46
47 2007;327-37.
48
49

50
51
52 27. Richter L, Norris S, Pettifor J, Yach D, Cameron N. Cohort Profile: Mandela's
53
54 children: the 1990 Birth to Twenty study in South Africa. *Int J Epidemiol*
55
56 2007;36:504-11.
57
58
59
60

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
28. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics* 2004;114:555-76.
 29. Horta BL, Gigante DP, Victora CG, Barros FC, Oliveira I, Silveira V. Early determinants of random blood glucose among adults of the 1982 birth cohort, Pelotas, Southern Brazil. *Rev Saude Publica* 2008; 42 (Suppl 2): 93-100.
 30. Kumar G, Sng BL, Kumar S. Correlation of capillary and venous glucometry with laboratory determination. *Prehosp Emerg Care* 2004;8:378-83.
 31. Petersen JR, Graves DF, Tacker DH, Okurodudu AO, Mohammad AA, Cardenas VJ. Comparison of POCT and central laboratory blood glucose results using arterial, capillary, and venous samples from MICU patients on tight glycaemic control. *Clinica Chimica Acta* 2008;396:10-13.
 32. World Health Organisation. Definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO consultation. Part 1: DDDiagnosis and Classification of Diabetes Mellitus. WHO, Geneva, 1999.
 33. Physical status: the use and interpretation of anthropometry. WHO Technical report series No 854. WHO, Geneva, 1995.
 34. Wells JCK, Gigante D, Wright A, Hallal PC, Victora CG. Validation of leg-to-leg

1
2
3 impedance for body composition assessment in male Brazilians aged 16-19 years.
4
5 International Journal of Body Composition Research 2003;1:69-75.
6
7

8
9
10 35. Ramirez-Zea M, Torun B, Martorell R, Stein AD. Anthropometric predictors of body
11 fat as measured by hydrostatic weighing in Guatemalan adults. Am J Clin Nutr
12 2006;83:795-802.
13
14
15
16

17
18
19 36. Durnin JV, Womersley J. Body fat assessed from total body density and its estimation
20 from skinfold thickness: measurements on 481 men and women aged from 16 to 72
21 years. Br J Nutr 1974;32:77-97.
22
23
24
25

26
27
28 37. Deurenberg P, Deurenberg-Yap M. Validation of skinfold thickness and hand-held
29 impedance measurements for estimation of body fat percentage among Singaporean
30 Chinese, Malay and Indian subjects. Asia Pac J Clin Nutr 2002;11:1-7.
31
32
33
34

35
36
37 38. Araujo CL, Victora CG, Hallal PC, Gigante DP. Breastfeeding and overweight in
38 childhood, evidence from the Pelotas 1993 birth cohort study. Int J Obesity
39 2006;30:500-6.
40
41
42
43
44

45
46
47 39. Sellen DW, Thompson AL, Hruschka DJ, Stein AD, Martorell R. Early determinants
48 of non-exclusive breastfeeding among Guatemalan infants. Adv Exp Med Biol
49 2004;554:299-301.
50
51
52
53

54
55
56 40. Ghosh S, Gidwani S, Mittal SK, Verma RK. Socio-cultural factors affecting
57 breastfeeding and other infant feeding practices in an urban community. Indian
58
59
60

1
2
3 Pediatrics 1976;13:827-32.
4
5
6

7
8 41. Daniels MC, Adair L. Breastfeeding influences cognitive development in Filipino
9 children. J Nutr 2005;135:2589-95.
10
11

12
13
14 42. Ellison GT, Wagstaff L, Cameron N, de Wet T. Geographical differences in infant
15 feeding patterns in disadvantaged communities. S African Med J 1997;87:1025-6.
16
17

18
19
20 43. Adair L, Dahly D. Quantifying the urban environment; a scale measure of urbanicity
21 outperforms the rural-urban dichotomy. Soc Sci Med 2007;64:1407-19.
22
23

24
25
26 44. Ma Y, Temprosa M, Fowler S, Prineas RJ, Montez MG, Brown-Friday J, Carrion-
27 Petersen ML, Whittington T. Evaluating the accuracy of an aneroid
28 sphygmomanometer in a clinical trial setting. Am J Hyperten 2009;22:263-266.
29
30

31
32
33 45. Rogoza AN, Pavlova TS, Sergeeva MV. Validation of A&D UA-767 device for the
34 self-measurement of blood pressure. Blood Pressure Monitoring 2000;5: 227-231.
35
36

37
38
39 46. Grim CE, Grim CM. Omron HEM-711 DLX home blood pressure monitor passes the
40 European Society of Hypertension International Validation Protocol. Blood Pressure
41 Monitoring 2008;13: 225-226.
42
43

44
45
46 47. Altunkan S, Ilman N, Kayaturk N, Altunkan E. Validation of the Omron M6 (HEM-
47 7001-E) upper-arm blood pressure measuring device according to the International
48 Protocol in adults and obese adults. Blood Pressure Monitoring 2007;12: 219-225.
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5
6 48. World Health Organisation. Definition and diagnosis of diabetes mellitus and
7
8 intermediate hyperglycaemia. Report of a WHO/IDF consultation. World Health
9
10 Organization, Geneva, 2006.
11
12
13
14
15 49. Burdette HL, Whitaker RC, Hall WC, Daniels ST. Breastfeeding, introduction of
16
17 complementary foods, and adiposity at 5 y of age. *AJCN* 2006;83:550-8.
18
19
20
21
22 50. Zive MM, McKay H, Frank-Spohrer GC, Broyles SL, Nelson JA, Nader PR. Infant-
23
24 feeding practices and adiposity in 4-y-old Anglo- and Mexican-Americans. *AJCN*
25
26 1992;55:1104–8.
27
28
29
30
31 51. Agras WS, Kraemer HC, Berkowitz RI, Hammer LD. Influence of early feeding style
32
33 on adiposity at 6 years of age. *J Pediatr* 1990;116:805–9.
34
35
36
37
38 52. Baker JL, Michaelsen KF, Rasmussen KM, Sorenson TI. Maternal prepregnant body
39
40 mass index, duration of breastfeeding, and timing of complementary food introduction
41
42 are associated with infant weight gain. *AJCN* 2004;80:1579-88.
43
44
45
46
47
48 53. Martin RM, Ness AR, Gunnell D, Emmett P, Davey Smith G and the ALSPAC study
49
50 team. Does breast-feeding in infancy lower blood pressure in childhood?; the Avon
51
52 Longitudinal Study of Parents and Children (ALSPAC). *Circulation* 2004;109:1259-
53
54 66.
55
56
57
58
59
60 54. Mayer-Davis EJ, Dabelea D, Lamichhane AP et al. Breastfeeding and type 2 diabetes

1
2
3 in the youth of three ethnic groups: the SEARCH for diabetes in youth case-control
4
5 study. *Diabetes Care* 2008;31:470-5.
6
7

8
9
10 55. Davis JN, Weigensberg MJ, Shaibi GQ et al. Influence of breastfeeding on obesity and
11
12 type 2 diabetes risk factors in Latino youth with a family history of type 2 diabetes.
13
14 *Diabetes Care* 2007;30:784-9.
15
16

17
18
19 56. Wadsworth M, Marshall S, Hardy R, Paul A. Breastfeeding and obesity; relation may
20
21 be accounted for by social factors. *BMJ* 1999;319:1576.
22
23
24

25
26
27 57. Kramer MS, Matush L, Vanilovich I et al. Effects of prolonged and exclusive
28
29 breastfeeding on child height, weight, adiposity, and blood pressure at age 6.5 years:
30
31 evidence from a large randomised trial. *AJCN* 2007;86:1717-21.
32
33
34

35
36 58. Lucas A, Morley R. Does early nutrition in infants born before term programme later
37
38 blood pressure? *BMJ* 1994;309:304-8.
39
40

41
42
43 59. Singhal A, Cole TJ, Lucas A. Early nutrition in preterm infants and later blood
44
45 pressure: two cohorts after randomised trials. *Lancet* 2001; 357: 413-9.
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Key messages box

- Previous research suggests that optimal breastfeeding and complementary feeding practices during infancy may reduce the risk of adult obesity, hypertension and type 2 diabetes.
- This evidence, mainly from high-income populations, is controversial because of confounding factors such as socio-economic status. We present data from 5 adult birth cohorts in low/middle-income settings
- We found no evidence that a longer duration of breastfeeding was associated with reduced adult adiposity, blood pressure or plasma glucose concentrations.
- Later introduction of complementary foods (solids) was associated with a small reduction in adult BMI, waist circumference and skinfold thickness.

Table 1: Characteristics of the 5 cohort studies and how infant feeding data were collected

COHORT name	Design	Cohort inception (year) and initial sample (N)	Last follow-up visit (year) and number examined (N)	Number included in this analysis (N) and percentage of original cohort	Initial cohort	How the infant feeding data were collected	Ever breast fed	Total duration of any breastfeeding	Duration predominant breastfeeding	Duration exclusive breastfeeding	Age at introduction of complementary foods
Pelotas, Brazil ²²	Prospective cohort	1982 5,914	2005 4,297	4,446 (75%)	Children born in the city's maternity hospital (>99% of all births) in 1982. All social classes included.	Mothers were asked at 6, 12, 20 & 48 months if they were breastfeeding and, if not, when they stopped. At 12 months (33% sub-sample) and 20 months (full cohort) they were asked at what age other liquids and foods were added (separately for other milks, herbal teas, juices, fruits, legumes, full family foods), 'Predominant' breastfeeding was defined as breastmilk plus water or herbal teas only. Data from earlier visits were used preferentially.	YES	YES	YES	NO	YES
INTCS, Guatemala ²³	Community trial	1969-77 2,392	2004 1,571	1,272 (53%)	Intervention trial of a high-energy and protein supplement in women, and children <7 yrs in 1969 and born during 1969-1977 in 4 villages.	Mothers were asked every 15 days, starting at birth, if they were breastfeeding. From the age of 15 months to 5 years, 24-hour recalls were performed every 3-6 months to record detailed dietary intakes.	YES	YES	NO	NO	NO

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

New Delhi, India ²⁴	Prospective cohort	1969-1972	1998-2002	8,181	1,583	1,526 (19%)	Babies born to an identified population of married women living in a defined area of Delhi. Primarily middle-class sample.	At each visit (birth, 3, 6, 9, 12, 18 & 24 months) project staff assigned babies to the <u>highest</u> applicable category from: 1) Entirely breastfed; 2) Breast+bottle fed; 3) Entirely bottle fed; 4) First solids; 5) 3-4 solid foods; 6) Adult diet. For example, if an infant had just started solid feeds, they were classified as category 4, even if they were still receiving breast milk.	YES	NO	NO	NO	YES
CLHNS Philippines ²⁵	Prospective cohort	1983-1984	2005	3,080	2,032	2,048 (66%)	Pregnant women living in 33 randomly selected neighbourhoods; 75% urban. All social classes included.	Data were collected every 2 months from 0-24 months, to determine if the baby was breastfed and whether it was fed any other foods/liquids. At each 2-monthly visit, a 24-hour recall of all foods and liquids was performed, allowing quantification of nutrient intakes.	YES	YES	YES	YES	YES
Birth-to-twenty South Africa ²⁶	Prospective cohort	1990	2005	3,273	2,100	1,620 (49%)	Babies born to pregnant women living in a defined urban geographical area. Predominantly poor, black sample.	Questionnaires were administered at 3, 6, 12 & 24 months. Mothers were asked if they had ever breastfed the baby; if they were still breastfeeding; if stopped, when they stopped; and if and when a) other milk feeds and b) semi-solid or solid foods were introduced.	YES	YES	YES	NO	YES
Variables used in this analysis									YES	YES	NO	NO	YES

In Brazil and the Philippines, the number included in this analysis exceeds the number of participants in the last follow-up study, because some data (for example height) was utilised from previous follow-up rounds.

Table 2 Patterns of infant feeding in the 5 cohorts

	Brazil N=4,446	Guatemala N=1,272	India N=1,526	Philippines N=2,048	South Africa N=1,620
Ever breastfed N (%)					
Yes	3964 (92.2)	739 (99.7)	1446 (99.9)	1934 (94.9)	1519 (94.9)
No	336 (7.8)	2 (0.3)	2 (0.1)	104 (5.1)	81 (5.1)
Data missing (N)	146	531	78	10	20
Duration of breastfeeding (months) N (%)					
None	336 (7.8)	2 (0.3)	No data on duration of breast feeding	104 (5.1)	81 (5.7)
0.01-1.00	997 (23.2)	2 (0.3)		120 (5.9)	103 (7.3)
1.01-3.00	1282 (29.8)	2 (0.3)		113 (5.5)	207 (14.6)
3.01-6.00	621 (14.4)	12 (1.8)		134 (6.6)	145 (10.2)
6.01-9.00	290 (6.7)	39 (5.8)		106 (5.2)	94 (6.6)
9.01-12.00	164 (3.8)	60 (8.9)		163 (8.0)	110 (7.8)
12.01-18.00	176 (4.1)	258 (38.1)		563 (27.6)	194 (13.7)
18.01-24.00	55 (1.3)	197 (29.1)		440 (21.6)	170 (12.0)
>24.00	379 (8.8)	105 (15.5)		295 (14.5)	315 (22.2)
Data missing (N)	146	595		10	201
Age of introduction of complementary foods (months) N (%)					
0-3.00	2874 (69.4)	No complementary foods introduced	0 (0.0)	117 (5.9)	922 (58.3)
3.01-6.00	1167 (28.2)		6 (1.0)	1630 (81.7)	592 (37.4)
6.01-9.00	81 (2.0)		50 (8.3)	238 (11.9)	53 (3.4)
9.01-12.00	22 (0.5)		254 (42.2)	10 (0.5)	12 (0.8)
12.01-18.00	0 (0.0)		220 (36.5)	0 (0.0)	1 (0.1)
> 18.00	0 (0.0)		72 (12.0)	0 (0.0)	1 (0.1)
Data missing (N)	302		924	53	39

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

Table 3 Characteristics of the cohort at adult follow-up

	BRAZIL		GUATEMALA		INDIA		PHILIPPINES		SOUTH AFRICA	
	Men Mean(SD)	Women Mean(SD)	Men Mean(SD)	Women Mean(SD)	Men Mean(SD)	Women Mean(SD)	Men Mean(SD)	Women Mean(SD)	Men Mean(SD)	Women Mean(SD)
Age	22.7(0.4)	22.7(0.4)	32.3(4.1)	32.5(4.1)	29.2(1.3)	29.2(1.4)	21.3(0.8)	21.1(1.0)	15.6(0.3)	15.6(0.3)
<u>Blood Pressure Outcomes</u>										
N	2208	1980	578	634	880	631	1080	962	753	834
SBP (mm Hg)	123(14)	111(13)	117(11)	108(131)	118(11)	107(11)	112(11)	99(10)	118(13)	111(12)
DBP (mm Hg)	76(12)	72(11)	72(9)	70(9)	78(10)	73(9)	76(10)	68(9)	68(10)	69(9)
Hypertension (%)	16.7	5.9	5.2	3.3	12.2	5.2	10.8	1.1	7.3	4.0
Pre-hypertension (%)	43.2	22.2	24.0	13.9	43.6	24.7	44.8	11.2	41.4	25.1
<u>Glucose Outcomes</u>										
N	1856	1758	437	558	869	623	933	837	570	616
Glucose (mmol/l)*	5.5(5.0,5.9)	5.2(4.8,5.6)	5.1(4.8,5.4)	5.1(4.7,5.4)	5.4(4.9,5.9)	5.3(4.8,5.8)	4.7(4.4,5.0)	4.5(4.2,4.8)	5.1(4.8)	4.9(4.6,5.2)
Diabetes (%)	4.3	3.2	1.8	3.6	3.7	3.4	0.3	0	0.4	0.2
IFG (%)	19.4	12.4	5.3	7.2	20.5	14.4	0.9	1.0	2.6	1.9
<u>Body Composition</u>										
N	2207	1979	557	594	886	640	1079	958	753	831
Height (cm)	173.7(6.9)	160.8(6.2)	162.8(6.0)	150.7(5.6)	169.7(6.4)	154.9(5.7)	163.0(5.8)	151.2(5.5)	166.3(8.1)	158.7(6.2)
BMI (kg/m ²)	23.8(4.1)	23.4(4.6)	24.7(3.6)	27.0(4.8)	24.9(4.3)	24.6(5.1)	21.0(3.1)	20.2(3.1)	19.7(3.4)	22.1(4.5)
Waist (cm)	80.9(10.1)	74.9(10.6)	86.7(9.1)	92.3(12.1)	90.2(12.1)	79.6(12.4)	72.0(7.5)	67.6(7.2)	69.7(8.3)	71.1(9.6)
Fat (%)	16.3(3.8)	N/A	20.5(6.6)	35.1(7.3)	24.2(5.9)	34.2(7.0)	16.7(5.1)	32.7(4.8)	15.7(7.8)	32.1(7.2)
Subscapular skinfold (mm)*	9.8(8.2,13.0)	N/A	12.9(9.2,18.6)	22.3(16.2,28.2)	23.0(16.3,30.3)	25.4(17.5,34.2)	11.0(9.0,14.0)	17.3(13.3,21.7)	N/A	N/A
Triceps skinfold (mm)*	8.8(6.8,13.0)	N/A	8.6(6.2,11.6)	20.1(15.4,24.6)	16.3(11.1,21.1)	26.1(18.1,32.7)	9.0(7.0,13.7)	19.3(15.7,24.0)	N/A	N/A
Overweight (%)	30.6	26.0	40.4	62.6	47.3	45.1	9.7	7.5	7.9	23.2
Obese (%)	7.5	8.8	9.3	24.7	9.6	13.1	2.0	1.0	3.1	6.8

* median and IQR for logged variables

Table 4. Pooled analysis of blood pressure and glucose outcomes with infant feeding exposures.

	Model 1			Model 2			p-het
	Effect Size			Effect Size			
	B	OR	95% CI	B	OR	95% CI	
Ever breastfed							
Systolic blood pressure (mmHg)	-1.06		-2.17 to 0.06	-0.71		-1.84 to 0.41	0.30
Diastolic blood pressure (mmHg)	-0.81		-1.73 to 0.11	-0.55		-1.49 to 0.40	0.03
Hypertension		0.78	0.59 to 1.05		0.81	0.59 to 1.11	0.56
Pre-hypertension		0.88	0.72 to 1.07		0.94	0.75 to 1.17	0.05
Glucose (mmol/l, logged, x 100)	0.26		-1.11 to 1.62	0.58		-0.86 to 2.02	0.96
Diabetes		1.26	0.63 to 2.50		1.25	0.63 to 2.51	0.97
IFG + Diabetes		0.88	0.64 to 1.21		0.92	0.67 to 1.27	0.54
Duration of breastfeeding (per category†)							
Systolic blood pressure (mm Hg)	0.14		0.02 to 0.26	0.12		-0.01 to 0.24	0.28
Diastolic blood pressure (mmHg)	0.10		0.00 to 0.20	0.10		-0.01 to 0.20	0.31
Hypertension		1.01	0.98 to 1.05		1.02	0.98 to 1.05	0.92
Pre-hypertension		1.02	0.99 to 1.04		1.02	0.99 to 1.04	0.05
Glucose (mmol/l, logged, x 100)	0.07		-0.07 to 0.20	0.06		-0.09 to 0.21	0.75
Diabetes		1.05	0.98 to 1.13		1.05	0.98 to 1.13	0.80
IFG + Diabetes		1.00	0.96 to 1.04		0.99	0.96 to 1.04	0.25
Duration of breastfeeding (quadratic per category†)							
Systolic blood pressure (mmHg)	0.09		0.04 to 0.14	0.08		0.03 to 0.14	0.08
Diastolic blood pressure (mmHg)	0.05		0.00 to 0.09	0.04		-0.01 to 0.08	0.05
Hypertension		1.02	1.00 to 1.03		1.02	1.00 to 1.03	0.26
Pre-hypertension		1.01	1.00 to 1.02		1.01	1.00 to 1.02	0.03
Glucose (mmol/l, logged, x 100)	0.04		-0.02 to 0.10	0.02		-0.05 to 0.08	0.99
Diabetes		1.03	1.00 to 1.06		1.03	1.00 to 1.06	0.71
IFG + Diabetes		1.02	1.00 to 1.03		1.01	1.00 to 1.03	0.89
Age at introduction of complementary foods (per category†)							
Systolic blood pressure (mm Hg)	0.11		-0.37 to 0.60	0.23		-0.28 to 0.73	0.62
Diastolic blood pressure (mmHg)	-0.14		-0.54 to 0.26	0.03		-0.40 to 0.45	0.74
Hypertension		1.09	0.95 to 1.25		1.12	0.97 to 1.30	0.82
Pre-hypertension		1.00	0.92 to 1.09		1.02	0.92 to 1.12	0.84
Glucose (mmol/l, logged, x 100)	0.12		-0.44 to 0.68	0.02		-0.59 to 0.62	0.70
Diabetes		1.07	0.81 to 1.40		1.01	0.76 to 1.35	0.17
IFG + Diabetes		0.99	0.87 to 1.13		0.95	0.82 to 1.09	0.28

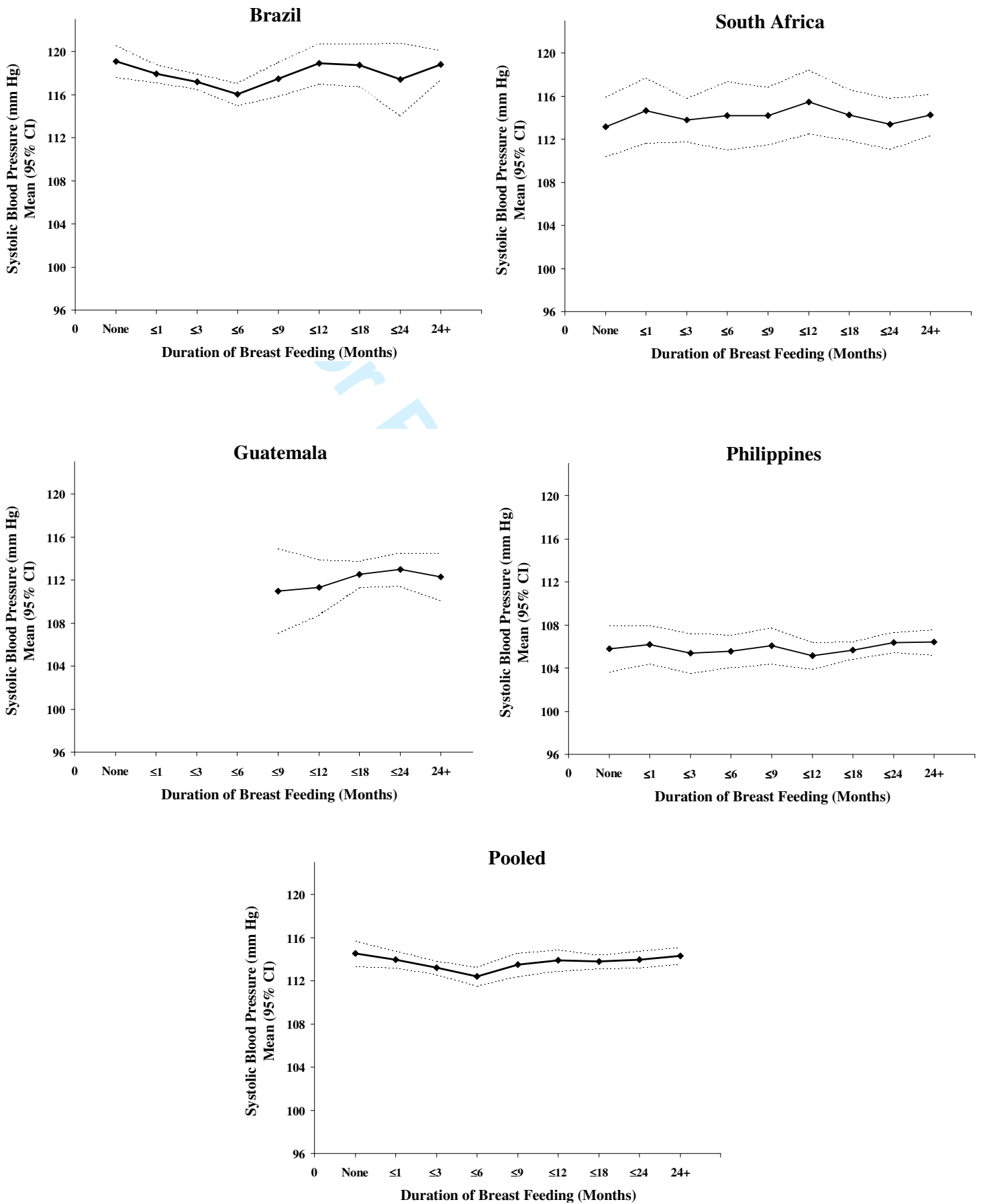
Data were analysed using linear regression (continuous outcomes, B=regression coefficient) or logistic regression (dichotomous outcomes, OR=odds ratio). Model 1 adjusted for subject's age and sex only; Model 2 further adjusted for confounders (maternal SES, education, age, smoking, race, and rural/urban residence, and birthweight) and adult BMI and height; p-het is the test for heterogeneity of the coefficient across studies in model 2. † categories are as defined in table 2. There were no non-linear associations with age at introduction of complementary foods, and these data have been omitted.

Table 5. Pooled analysis of body composition outcomes with infant feeding exposures.

	Model 1			Model 2			p-het
	Effect Size			Effect Size			
	B	OR	95% CI	B	OR	95% CI	
Ever breastfed							
BMI (kg/m ²)	-0.12		-0.49 to 0.25	-0.21		-0.60 to 0.17	0.33
Waist (cm)	-0.62		-1.52 to 0.27	-0.67		-1.59 to 0.25	0.09
% fat	-0.17		-0.82 to 0.47	-0.06		-0.70 to 0.59	0.33
Subscapular (mm, logged)	-0.03		-0.09 to 0.02	-0.02		-0.07 to 0.03	0.33
Triceps (mm, logged)	-0.05		-0.10 to 0.01	-0.03		-0.09 to 0.02	0.13
Obesity		0.78	0.55 to 1.11		0.77	0.54 to 1.11	0.75
Overweight/obesity		0.87	0.70 to 1.09		0.84	0.67 to 1.06	0.05
Duration of breastfeeding (per category†)							
BMI (kg/m ²)	0.03		-0.01 to 0.07	0.04		0.00 to 0.08	0.12
Waist (cm)	-0.01		-0.10 to 0.08	0.05		-0.05 to 0.15	0.18
% fat	-0.05		-0.12 to 0.01	0.001		-0.07 to 0.07	0.33
Subscapular (mm, logged)	-0.009		-0.014 to -0.003	-0.002		-0.008 to 0.003	0.67
Triceps (mm, logged)	-0.011		-0.017 to -0.006	-0.004		-0.01 to 0.002	0.65
Obesity		1.03	0.99 to 1.07		1.04	1.00 to 1.09	0.35
Overweight/obesity		1.01	0.99 to 1.04		1.02	0.99 to 1.04	0.66
Duration of breastfeeding (quadratic per category†)							
BMI (kg/m ²)	0.002		-0.015 to 0.019	0.011		-0.007 to 0.029	0.21
Waist (cm)	0.006		-0.033 to 0.046	0.030		-0.012 to 0.072	0.53
% fat	-0.016		-0.044 to 0.012	0.006		-0.022 to 0.034	0.84
Subscapular (mm, logged)	-0.001		-0.003 to 0.002	0.001		-0.001 to 0.003	0.68
Triceps (mm, logged)	-0.001		-0.003 to 0.002	0.001		-0.001 to 0.004	0.26
Obesity		1.01	0.99 to 1.03		1.01	0.99 to 1.03	0.33
Overweight/obesity		1.00	0.99 to 1.01		1.01	0.99 to 1.02	0.33
Age at introduction of complementary foods (per category†)							
BMI (kg/m ²)	-0.25		-0.41 to -0.10	-0.23		-0.40 to -0.06	0.74
Waist (cm)	-0.70		-1.08 to -0.33	-0.58		-0.97 to -0.18	0.40
% body fat	-0.31		-0.56 to -0.06	-0.19		-0.44 to 0.07	0.84
Subscapular (mm, logged)	-0.05		-0.07 to -0.02	-0.03		-0.05 to -0.01	0.38
Triceps (mm, logged)	-0.03		-0.06 to -0.01	-0.01		-0.03 to 0.02	0.55
Obesity		0.90	0.77 to 1.06		0.91	0.77 to 1.08	0.84
Overweight/obesity		0.88	0.80 to 0.97		0.88	0.80 to 0.98	0.60

Data were analysed using linear regression (continuous outcomes, B=regression coefficient) or logistic regression (dichotomous outcomes, OR=odds ratio). Model 1 adjusted for subject's age and sex only; Model 2 further adjusted for confounders (maternal SES, education, age, smoking, race, and rural/urban residence, and birthweight) and adult height; p-het is the test for heterogeneity of the coefficient of model 2 across studies. † categories are as defined in table 2. There were no non-linear associations with age at introduction of complementary foods, and these data have been omitted.

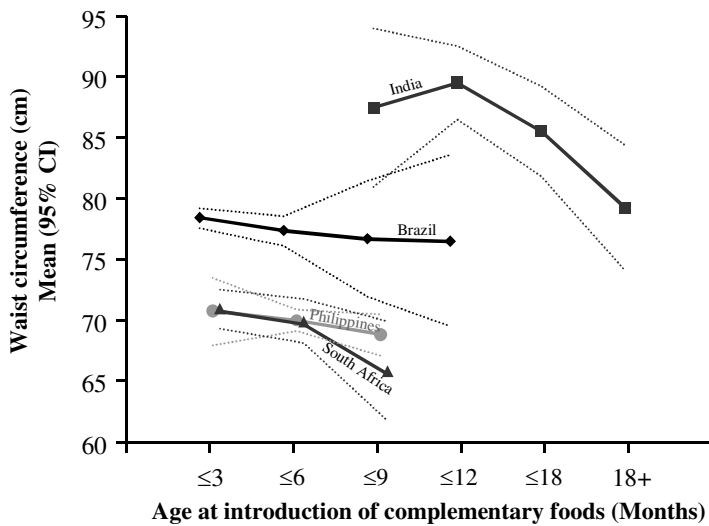
Figure 1 Associations of duration of breastfeeding with systolic blood pressure in the four cohorts with available data, and in the pooled data



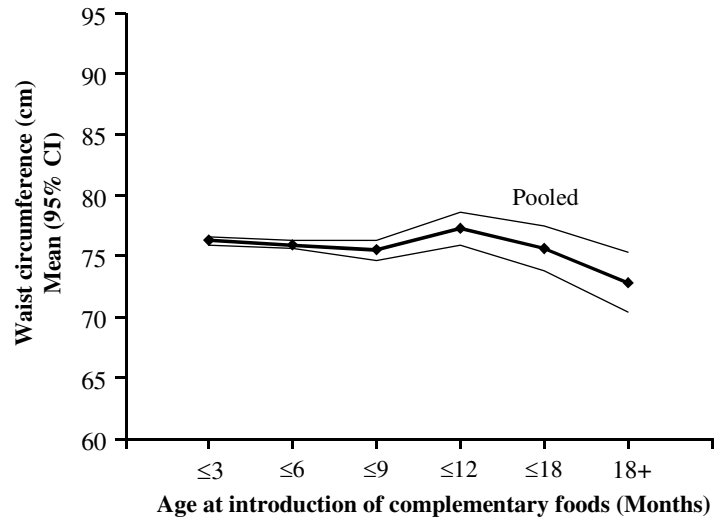
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 2 Associations of age of introduction of complementary foods with adult waist circumference (a and b), and subscapular skinfold measurement (c and d) (fully adjusted models) in the four cohorts with available data separately and pooled

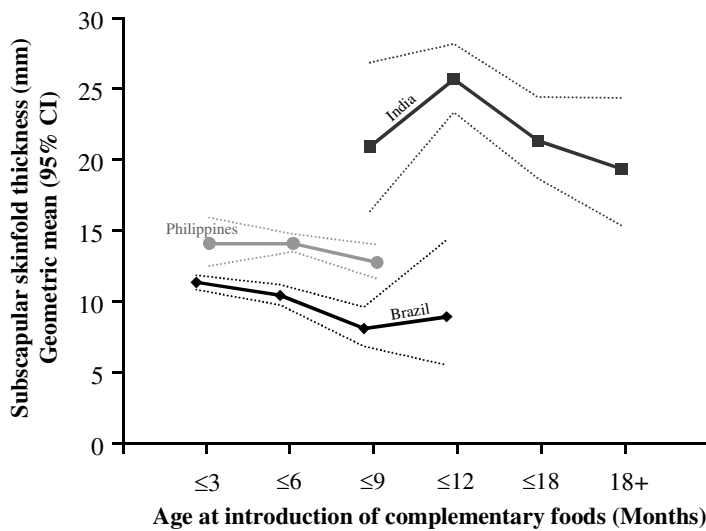
(a) Waist circumference



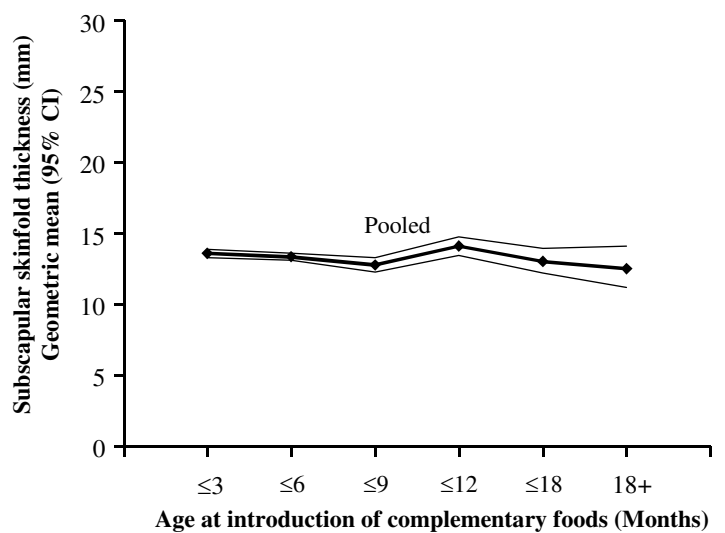
(b) Waist circumference (pooled data)



(c) Subscapular skinfold



(d) Subscapular skinfold (pooled data)



Additional online material Table A Infant feeding patterns and socio-economic status at birth

	Brazil					Guatemala					India					Philippines					South Africa				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
N	880	2181	846	267	250	253	249	231	228	205	31	161	334	755	245	467	355	410	420	396	423	325	432	291	149
Ever breastfed																									
Yes	90	92	93	93	97	100	100	100	98	100	100	100	99	100	100	99	98	97	93	88	96	96	95	93	93
No	10	8	7	7	3	0	0	0	2	0	0	0	1	0	0	1	2	3	7	12	4	4	5	7	7
N	4280					696					1448					2038					1600				
p ^{hetero}	0.002					0.06					0.1					<0.001					0.3				
p ^{linear}	<0.001					0.2					0.3					<0.001					0.05				
Duration of breastfeeding (months)																									
None	10	8	7	7	3	0	0	0	2	0	No data					1	2	3	7	12	5	4	5	8	8
0.01-1.00	25	24	23	15	22	0	0	0	0	1	No data					3	3	4	7	13	8	6	5	10	8
1.01-3.00	28	30	34	33	23	1	0	0	0	1	No data					4	4	4	7	9	10	13	17	15	22
3.01-6.00	11	14	16	15	21	1	2	2	0	3	No data					4	4	6	10	9	9	8	12	10	13
6.01-9.00	6	6	6	13	15	5	7	8	4	3	No data					3	5	7	5	7	4	7	6	8	14
9.01-12.00	2	4	3	5	7	6	7	8	10	7	No data					6	7	9	9	9	7	8	6	10	9
12.01-18.00	5	4	4	5	4	35	41	50	38	27	No data					35	30	28	24	20	15	13	16	12	8
18.01-24.00	1	1	1	1	1	37	28	24	30	30	No data					27	24	23	21	14	12	17	13	9	4
>24.00	11	9	7	7	5	15	16	8	16	28	No data					16	21	16	11	9	29	24	21	18	15
N	4280					638					No data					2038					1419				
p ^{hetero}	<0.001					0.01					No data					<0.001					<0.001				
p ^{linear}	0.6					1.0					No data					<0.001					<0.001				
Age at introduction of complementary foods (months)																									
0-3.00	61	69	74	79	82	No data					0	0	0	0	0	4	3	5	9	9	58	62	62	55	47
3.01-6.00	33	30	24	21	17	No data					0	0	0	1	3	81	84	84	79	81	38	32	35	42	50
6.01-9.00	4	2	2	0	0	No data					0	2	6	11	8	14	13	11	12	9	3	5	3	2	4
9.01-12.00	1	0	0	0	0	No data					33	47	43	40	45	0	0	1	1	1	1	1	0	1	0
12.01-18.00	0	0	0	0	0	No data					58	34	38	37	33	0	0	0	0	0	0	0	0	0	0
>18.00	0	0	0	0	0	No data					8	17	13	11	10	0	0	0	0	0	0	0	0	0	0
N	4125					No data					602					1995					1581				
p ^{hetero}	<0.001					No data					0.2					0.001					0.06				
p ^{linear}	<0.001					No data					0.008					<0.001					0.4				

Data presented are column percentages. Socio-economic status at birth is categorised into five groups from least (1) to most (5) advantaged using the original scoring system in each cohort. P^{hetero} is the p value derived from a Chi square test, and p^{linear} from a Chi square test for linear by linear association.

Additional online material Table B Infant feeding patterns and maternal education status (years of schooling)

	Brazil		Guatemala		India		Philippines		South Africa	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Ever breastfed										
Yes	6.6 (4.2)	3959	1.3 (1.5)	734	12.6 (2.9)	1446	7.3 (3.6)	1934	10.0 (2.5)	1513
No	5.6 (3.6)	336	1.5 (0.7)	2	12.5 (2.1)	2	10.2 (4.0)	104	9.8 (2.4)	80
ALL	6.5 (4.1)	4295	1.31 (1.5)	736	12.6 (2.9)	1448	7.4 (3.7)	2038	10.0 (2.5)	1593
p	<0.001		0.8		1.0		<0.001		0.7	
Duration of breastfeeding (months)										
None	5.6 (3.6)	336	1.5 (0.7)	2	No data		10.2 (4.0)	104	9.8 (2.4)	80
0.01-1.00	6.3 (3.8)	995	0.5 (0.7)	2			10.0 (4.0)	120	10.0 (2.2)	103
1.01-3.00	6.5 (3.9)	1281	1.5 (2.1)	2			9.7 (3.8)	113	10.2 (2.3)	207
3.01-6.00	7.2 (4.2)	621	2.8 (1.9)	12			9.2 (3.7)	134	10.0 (2.6)	145
6.01-9.00	7.9 (5.2)	289	1.4 (1.4)	38			8.6 (3.6)	106	10.2 (2.2)	94
9.01-12.00	7.5 (4.8)	164	1.3 (1.6)	59			7.5 (3.4)	163	9.8 (2.7)	108
12.01-18.00	6.6 (4.9)	175	1.2 (1.4)	255			6.9 (3.2)	563	10.3 (2.3)	194
18.01-24.00	6.2 (4.1)	55	1.2 (1.5)	197			6.3 (3.2)	440	10.1 (2.3)	170
>24.00	5.2 (3.7)	379	1.2 (1.4)	105			5.9 (3.3)	295	9.4 (2.7)	314
ALL	6.5 (4.1)	4395	1.2 (1.5)	672			7.4 (3.7)	2038	9.9 (2.5)	1415
p ^{hetero}	<0.001		0.06				<0.001		0.001	
p ^{linear}	0.6		0.08				<0.001		0.02	
Age at introduction of complementary foods (months)										
0-3.00	6.8 (4.1)	2872	No data		-	0	8.3 (4.2)	117	9.9 (2.5)	918
3.01-6.00	6.0 (4.0)	1165			14.3 (2.0)	6	7.5 (3.7)	1630	10.1 (2.3)	590
6.01-9.00	4.2 (3.2)	80			13.2 (1.8)	50	6.1 (3.2)	238	9.9 (2.1)	53
9.01-12.00	5.6 (3.9)	22			12.7 (2.8)	254	6.0 (3.3)	10	8.7 (3.8)	12
12.01-18.00	-	0			12.6 (2.8)	220	-	0	12.0 (-)	1
>18.00	-	0			12.5 (3.1)	72	-	0	12.0 (-)	1
ALL	6.5 (4.1)	4139			12.7 (2.8)	602	7.4 (3.7)	1995	10.0 (2.4)	1575
p ^{hetero}	<0.001				0.3		<0.001		0.2	
p ^{linear}	<0.001				0.09		<0.001		0.4	

Data presented are means years of schooling. P^{hetero} is the p value derived from a one way analysis of variance and p^{linear} from a one way analysis of variance test for linear trend.

Additional online material Table C Infant feeding patterns and maternal age

	Brazil		Guatemala		India		Philippines		South Africa	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Ever breastfed										
Yes	26.0 (6.1)	3964	27.9 (7.1)	739	No data		26.5 (6.0)	1934	25.6 (6.1)	1518
No	26.6 (6.9)	336	33.3 (5.9)	2			28.7 (6.1)	104	25.1 (6.2)	81
ALL	26.0 (6.2)	4300	27.9 (7.1)	741			26.6 (6.0)	2038	25.6 (6.1)	1599
p	0.07		0.3				<0.001		0.4	
Duration of breastfeeding (months)										
None	26.6 (6.9)	336	33.3 (5.9)	2	No data		28.7 (6.1)	104	25.1 (6.2)	81
0.01-1.00	25.3 (5.9)	997	29.1 (9.7)	2			27.2 (5.6)	120	26.1 (6.2)	103
1.01-3.00	25.6 (5.9)	1282	21.0 (2.4)	2			25.5 (5.6)	113	26.0 (6.1)	207
3.01-6.00	26.2 (6.0)	621	27.3 (7.0)	12			26.2 (5.6)	134	26.1 (6.3)	145
6.01-9.00	26.5 (5.9)	290	26.7 (6.4)	39			25.9 (5.9)	106	25.9 (5.9)	94
9.01-12.00	26.6 (6.5)	164	26.3 (7.6)	60			24.4 (5.3)	163	25.7 (6.4)	110
12.01-18.00	26.7 (6.4)	176	26.1 (6.7)	258			25.7 (5.6)	563	24.2 (5.2)	194
18.01-24.00	27.0 (6.4)	55	29.4 (6.5)	197			26.8 (5.9)	440	24.5 (5.8)	170
>24.00	27.7 (6.7)	379	31.0 (7.9)	105			29.4 (6.7)	295	26.1 (6.6)	314
ALL	26.0 (6.2)	4300	27.9 (7.1)	677			26.6 (6.0)	2038	25.5 (6.1)	1418
p ^{hetero}										
p ^{linear}										
Age at introduction of complementary foods (months)										
0-3.00	26.2 (6.2)	2874	No data		No data		26.8 (6.5)	117	25.2 (6.0)	921
3.01-6.00	25.9 (6.2)	1167					26.4 (5.9)	1630	26.1 (6.2)	592
6.01-9.00	25.3 (6.5)	81					27.7 (6.4)	238	26.8 (6.0)	53
9.01-12.00	24.9 (6.1)	22					30.5 (8.3)	10	22.8 (7.3)	12
12.01-18.00	-	0					-	0	20.0 (-)	1
>18.00	-	0					-	0	26.0 (-)	1
ALL	26.1 (6.2)	4144					26.6 (6.0)	1995	25.6 (6.1)	1580
p ^{hetero}	0.2						0.004		0.02	
p ^{linear}	0.04						0.009		0.03	

Data presented are mean maternal age in years. P^{hetero} is the p value derived from a one way analysis of variance and p^{linear} from a one way analysis of variance test for linear trend.

Additional online material Table D Infant feeding patterns and maternal smoking in pregnancy

	Brazil		Philippines		South Africa	
	Non-smoker N=2880	Smoker N=1566	Non-smoker N=1777	Smoker N=271	Non-smoker N=912	Smoker N=55
Ever breastfed	N=4300		N=2038		N=947	
Yes	92	93	95	96	96	85
No	8	7	5	4	4	15
p for difference non-smokers v smokers	0.5		0.3		<0.001	
Duration of breastfeeding (months)	N=4300		N=2038		N=787	
None	8	7	5	4	4	17
0.01-1.00	21	27	6	2	9	13
1.01-3.00	28	33	6	3	15	33
3.01-6.00	15	14	7	3	11	15
6.01-9.00	7	6	6	3	6	2
9.01-12.00	4	3	8	6	7	10
12.01-18.00	5	3	28	27	14	0
18.01-24.00	2	1	21	28	13	0
>24.00	10	7	13	24	22	10
p ^{hetero}	<0.001		<0.001		<0.001	
p ^{linear}	<0.001		<0.001		<0.001	
Age at introduction of complementary foods (months)	N=4144		N=1995		N=930	
0-3.00	70	68	6	6	58	42
3.01-6.00	27	30	83	76	38	54
6.01-9.00	2	2	11	18	3	4
9.01-12.00	1	0	1	0	1	0
12.01-18.00	0	0	0	0	0	0
>18.00	0	0	0	0	0	0
p ^{hetero}	0.3		0.01		0.2	
p ^{linear}	0.5		0.07		0.1	

Data presented are column percentages. No data on maternal smoking available from India or Guatemala. P^{hetero} and p^{linear} are derived from logistic regression analysis.

Additional online material Table E Infant feeding patterns and maternal race/skin colour (Brazil and South Africa only)

	BRAZIL				SOUTH AFRICA			
	Black N=655	White N=3162	Asian N=146	Mixed N=229	Black N=1382	White N=37	Asian N=24	Mixed N=177
Ever breastfed								
Yes	94 (591)	92 (2827)	88 (120)	91 (205)	96 (1308)	86 (32)	87 (20)	91 (159)
No	6 (38)	8 (241)	12 (17)	9 (21)	4 (58)	14 (5)	13 (3)	9 (15)
p ^{hetero}	0.06				0.002			
Duration of breastfeeding (months)								
None	6 (38)	8 (241)	12 (17)	9 (21)	5 (58)	15 (5)	16 (3)	9 (15)
0.01-1.00	18 (111)	24 (748)	23 (31)	24 (55)	6 (76)	12 (4)	16 (3)	12 (20)
1.01-3.00	27 (168)	30 (931)	28 (38)	28 (63)	12 (147)	21 (7)	32 (6)	29 (47)
3.01-6.00	14 (87)	15 (445)	15 (21)	14 (31)	9 (109)	15 (5)	16 (3)	17 (28)
6.01-9.00	7 (44)	7 (210)	5 (7)	6 (13)	6 (77)	15 (5)	11 (2)	6 (10)
9.01-12.00	5 (31)	4 (115)	4 (5)	2 (5)	8 (94)	18 (6)	0 (0)	6 (10)
12.01-18.00	7 (47)	3 (107)	4 (5)	4 (9)	16 (189)	0 (0)	5 (1)	2 (4)
18.01-24.00	2 (13)	1 (37)	1 (1)	1 (2)	14 (164)	0 (0)	5 (1)	3 (5)
>24.00	14 (90)	8 (234)	9 (12)	12 (27)	24 (290)	3 (1)	0 (0)	15 (24)
p ^{hetero}	<0.001				<0.001			
Age at introduction of complementary foods (months)								
0-3.00	62 (373)	71 (2114)	69 (91)	64 (138)	61 (825)	39 (14)	25 (5)	46 (78)
3.01-6.00	34 (206)	27 (790)	27 (35)	33 (72)	35 (475)	56 (20)	65 (13)	50 (84)
6.01-9.00	3 (21)	1 (44)	3 (4)	2 (5)	3 (43)	6 (2)	10 (2)	4 (6)
9.01-12.00	1 (6)	0 (12)	1 (1)	0 (1)	1 (11)	0 (0)	0 (0)	1 (1)
p ^{hetero}	<0.001				0.006			

Data presented are column percentages (N). P^{hetero} values are derived from logistic regression analysis.

Additional online material Table F Infant feeding patterns and urbanicity index (Philippines)

	Mean (SD)	N
Ever breastfed		
Yes	29.2 (12.8)	1934
No	34.8 (12.0)	104
ALL	29.5 (12.8)	2038
p	<0.001	
Duration of breastfeeding (months)		
None	34.8 (12.0)	104
0.01-1.00	34.6 (10.9)	120
1.01-3.00	31.7 (11.4)	113
3.01-6.00	33.5 (12.1)	134
6.01-9.00	32.8 (11.9)	106
9.01-12.00	30.2 (12.4)	163
12.01-18.00	27.8 (12.6)	563
18.01-24.00	28.0 (13.2)	440
>24.00	27.0 (13.3)	295
ALL	29.5 (12.8)	2038
p ^{hetero}	<0.001	
p ^{linear}	<0.001	
Age at introduction of complementary foods (months)		
0-3.00	34.4 (12.0)	117
3.01-6.00	29.5 (12.8)	1630
6.01-9.00	26.7 (12.6)	238
9.01-12.00	30.5 (14.2)	10
ALL	29.5 (12.8)	1995
p ^{hetero}	<0.001	
p ^{linear}	<0.001	

Data presented are mean urbanicity index. P^{hetero} values are derived from one way analysis of variance and p^{linear} from one way analysis of variance tests for linear trend.

Additional online material Table G Infant feeding patterns and birth weight

	Brazil		Guatemala		India		Philippines		South Africa	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Ever breastfed										
Yes	3.24 (0.50)	3963	3.05 (0.47)	580	2.85 (0.41)	1314	3.02 (0.41)	1903	3.08 (0.49)	1515
No	3.08 (0.67)	336	2.84 (0.22)	2	2.70 (0.31)	2	2.97 (0.51)	104	2.82 (0.71)	81
ALL	3.23 (0.52)	4299	3.05 (0.47)	582	2.85 (0.41)	1316	3.01 (0.42)	2007	3.06 (0.51)	1596
p	<0.001		0.5		0.5		0.4		<0.001	
Duration of breastfeeding (months)										
None	3.08 (0.67)	336	2.84 (0.22)	2	No data		2.97 (0.51)	104	2.82 (0.71)	81
0.01-1.00	3.19 (0.53)	997	-	0			3.03 (0.49)	119	3.11 (0.51)	103
1.01-3.00	3.24 (0.50)	1281	3.13 (0.53)	2			2.92 (0.44)	112	3.08 (0.55)	205
3.01-6.00	3.24 (0.48)	621	2.96 (0.46)	10			2.97 (0.44)	133	3.06 (0.52)	145
6.01-9.00	3.32 (0.47)	290	3.02 (0.54)	32			3.03 (0.42)	106	3.09 (0.52)	94
9.01-12.00	3.30 (0.47)	164	3.09 (0.42)	51			2.99 (0.41)	162	3.05 (0.47)	110
12.01-18.00	3.30 (0.49)	176	3.03 (0.46)	193			3.01 (0.39)	555	3.09 (0.46)	192
18.01-24.00	3.38 (0.51)	55	3.05 (0.46)	162			3.03 (0.39)	429	3.09 (0.46)	170
>24.00	3.28 (0.51)	379	3.02 (0.49)	81			3.03 (0.44)	287	2.06 (0.48)	315
ALL	3.23 (0.52)	4299	3.04 (0.46)	533			3.01 (0.42)	2007	3.06 (0.51)	1415
p ^{hetero}	0.001		0.9				0.6		0.007	
p ^{linear}	<0.001		1.0				0.07		0.1	
Age at introduction of complementary foods (months)										
0-3.00	3.25 (0.52)	2873	No data		-	0	2.99 (0.42)	115	3.07 (0.51)	921
3.01-6.00	3.21 (0.54)	1167			2.81 (0.39)	6	3.01 (0.42)	1605	3.05 (0.52)	589
6.01-9.00	3.10 (0.51)	81			2.95 (0.44)	45	3.00 (0.41)	234	3.17 (0.43)	53
9.01-12.00	3.15 (0.52)	22			2.94 (0.42)	235	2.80 (0.39)	10	2.89 (0.39)	12
12.01-18.00	-	0			2.81 (0.42)	197	-	0	3.24 (-)	1
>18.00	-	0			2.75 (0.42)	63	-	0	3.51 (-)	1
ALL	3.23 (0.52)	4143			2.87 (0.43)	546	3.01 (0.42)	1964	3.07 (0.51)	1577
p ^{hetero}	0.4				0.3		0.3		0.3	
p ^{linear}	0.006				0.001		0.6		1.0	

Data presented are mean birth weight in kg. P^{hetero} values are derived from one way analysis of variance and p^{linear} from one way analysis of variance tests for linear trend

Additional online material Table H Infant feeding patterns and weight at age two years

	Brazil		Guatemala		India		Philippines		South Africa	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
Ever breastfed										
Yes	11.13 (1.61)	3757	9.69 (1.16)	544	10.08 (1.28)	1368	9.78 (1.14)	1835	11.40 (1.67)	810
No	11.00 (1.58)	316	9.51 (-)	1	10.80 (0.45)	2	10.15 (1.33)	95	11.49 (1.38)	45
ALL	11.12 (1.60)	4073	9.69 (1.16)	545	10.08 (1.27)	1370	9.80 (1.15)	1930	11.41 (1.65)	855
p										
Duration of breastfeeding (months)										
None	11.00 (1.58)	316	7.51 (-)	1	No data		10.15 (1.33)	95	11.49 (1.38)	45
0.01-1.00	11.17 (1.60)	929	9.90 (-)	1			10.32 (1.49)	98	11.90 (1.79)	57
1.01-3.00	11.14 (1.60)	1226	-	0			9.97 (1.35)	97	11.27 (1.67)	110
3.01-6.00	11.23 (1.57)	591	10.38 (1.75)	5			9.91 (1.28)	118	11.34 (1.65)	76
6.01-9.00	11.29 (1.67)	275	9.41 (1.25)	16			9.78 (1.19)	100	11.44 (1.61)	52
9.01-12.00	11.06 (1.73)	155	9.79 (1.15)	30			9.79 (1.16)	153	11.97 (1.83)	59
12.01-18.00	11.15 (1.73)	169	9.85 (1.13)	226			9.73 (1.10)	547	11.40 (1.58)	125
18.01-24.00	11.24 (1.53)	54	9.48 (1.16)	168			9.75 (1.00)	427	11.23 (1.66)	107
>24.00	10.68 (1.49)	358	9.64 (1.13)	97			9.61 (1.07)	295	11.26 (1.68)	193
ALL	11.12 (1.60)	4073	9.68 (1.16)	544			9.80 (1.15)	1930	11.41 (1.67)	824
p ^{hetero}	<0.001		0.02				0.4		0.07	
p ^{linear}	0.002		0.1				<0.001		0.1	
Age at introduction of complementary foods (months)										
0-3.00	11.23 (1.59)	2825	No data		-	0	9.95 (1.26)	111	11.43 (1.66)	512
3.01-6.00	10.91 (1.60)	1147			10.78 (1.31)	5	9.83 (1.15)	1573	11.35 (1.61)	312
6.01-9.00	10.15 (1.58)	78			10.73 (1.15)	49	9.59 (1.12)	229	11.64 (2.10)	23
9.01-12.00	10.76 (1.19)	21			10.31 (1.19)	245	9.01 (1.41)	9	11.28 (1.78)	6
12.01-18.00	-	0			9.91 (1.21)	217	-	0	-	0
>18.00	-	0			9.64 (1.34)	71	-	0	10.00 (-)	1
ALL	11.12 (1.60)	4071			10.12 (1.25)	587	9.80 (1.15)	1922	11.41 (1.65)	854
p ^{hetero}	0.02				0.9		0.4		0.7	
p ^{linear}	<0.001				<0.001		<0.001		0.7	

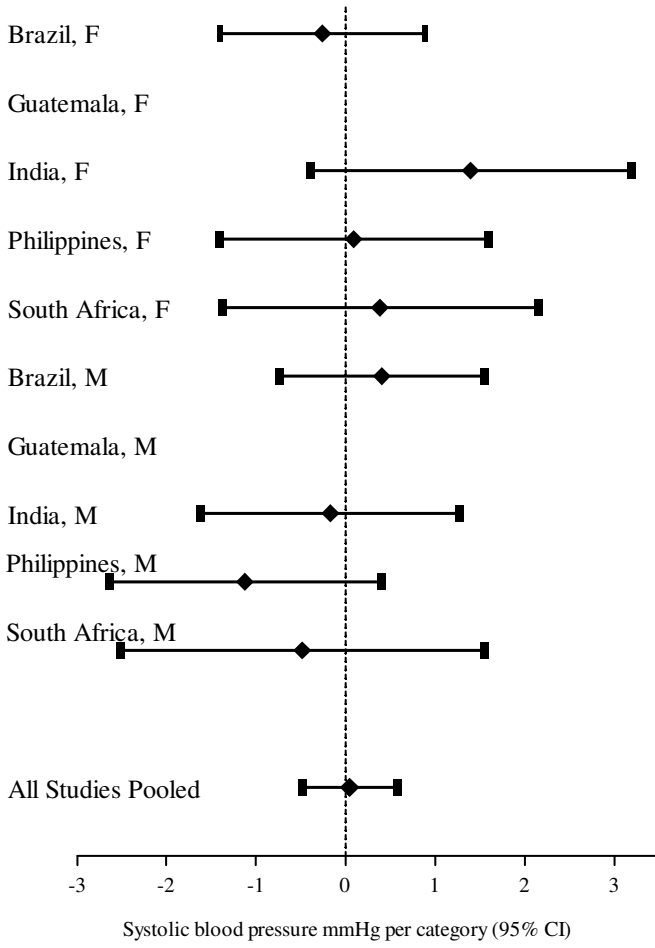
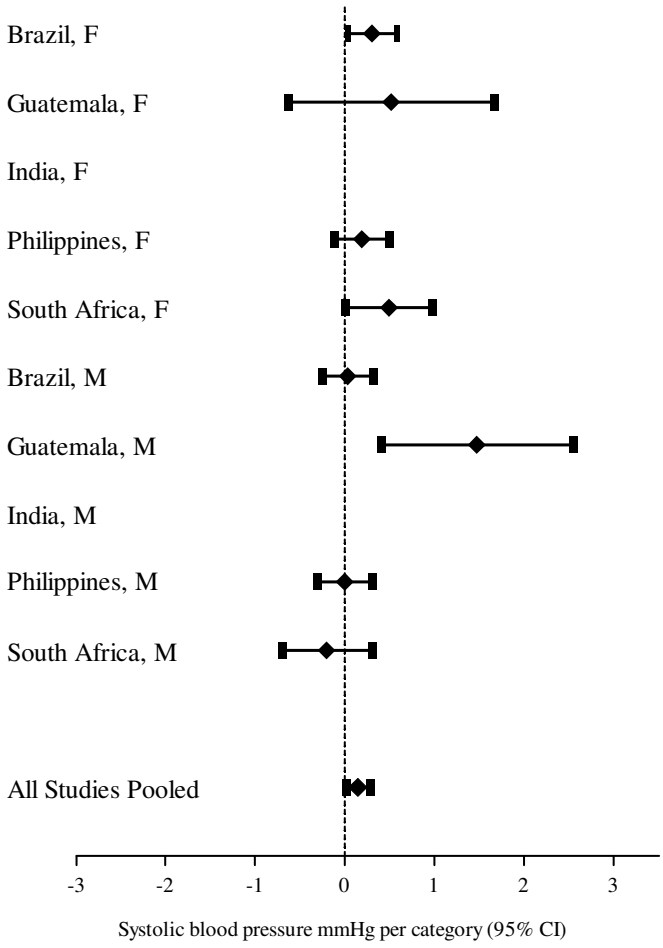
Data are mean weight in kg. P^{hetero} values are derived from one way analysis of variance and p^{linear} from one way analysis of variance tests for linear trend

Additional online material Figure J: Forest plots showing associations in each cohort between (a) duration of breastfeeding and (b) age of introduction of complementary foods and SYSTOLIC BLOOD PRESSURE

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

a) Duration of breastfeeding

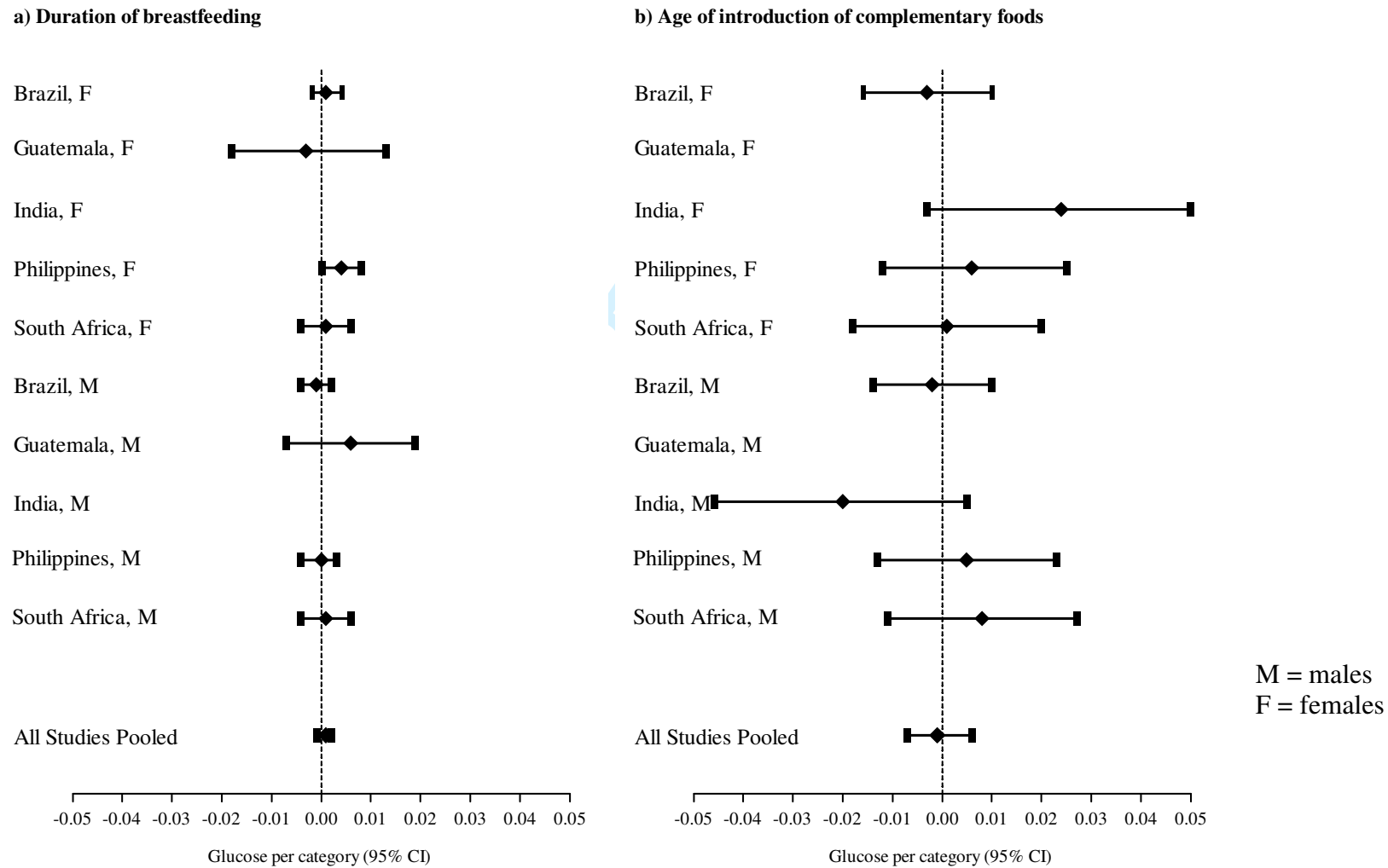
b) Age of introduction of complementary foods



M = males
F = females

Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

Additional online material Figure K: Forest plots showing associations in each cohort between (a) duration of breastfeeding and (b) age of introduction of complementary foods and PLASMA GLUCOSE

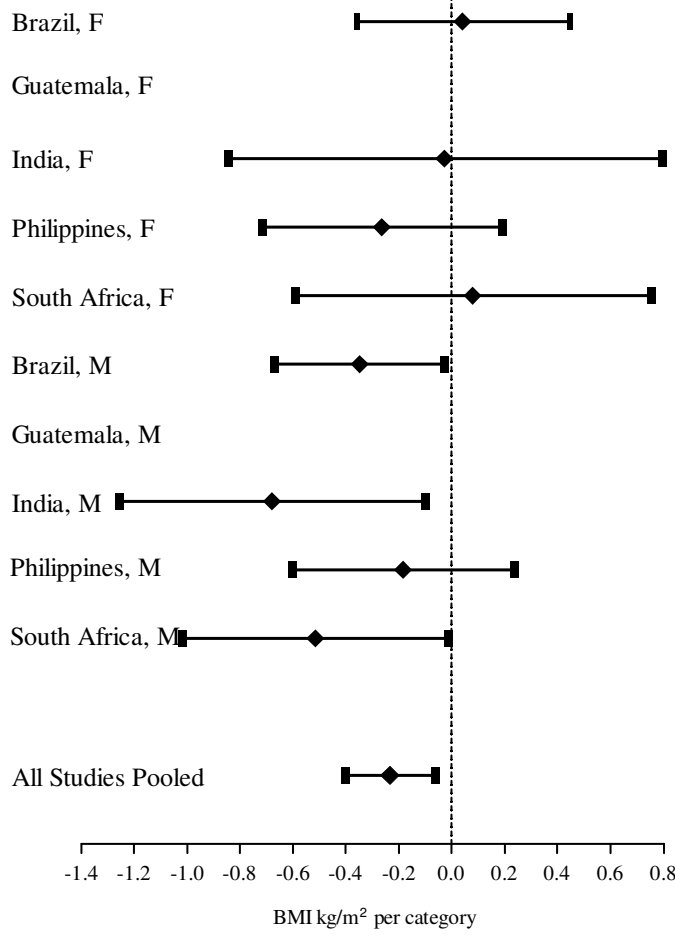
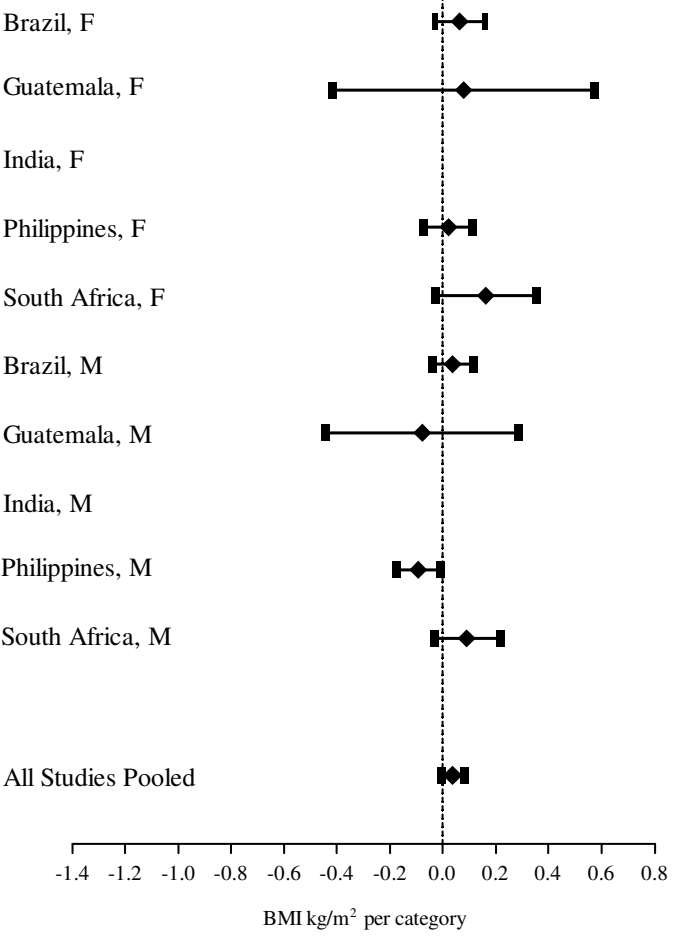


Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

Additional online material Figure L: Forest plots showing associations in each cohort between (a) duration of breastfeeding and (b) age of introduction of complementary foods and BODY MASS INDEX

a) Duration of breastfeeding

b) Age of introduction of complementary foods



M = males
F = females

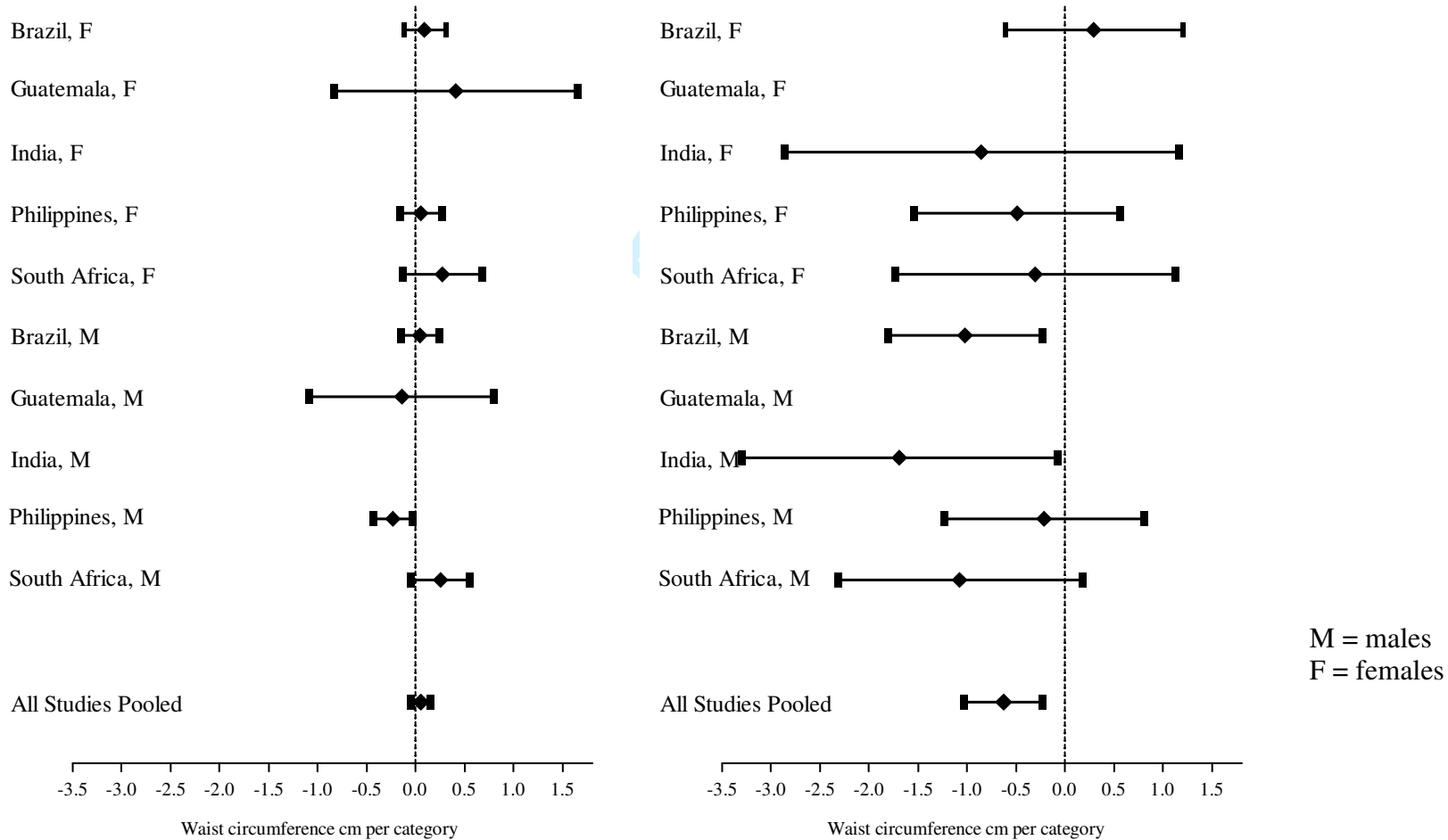
Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

Additional online material Figure M: Forest plots showing associations in each cohort between (a) duration of breastfeeding and (b) age of introduction of complementary foods and WAIST CIRCUMFERENCE

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

a) Duration of breastfeeding

b) Age of introduction of complementary foods

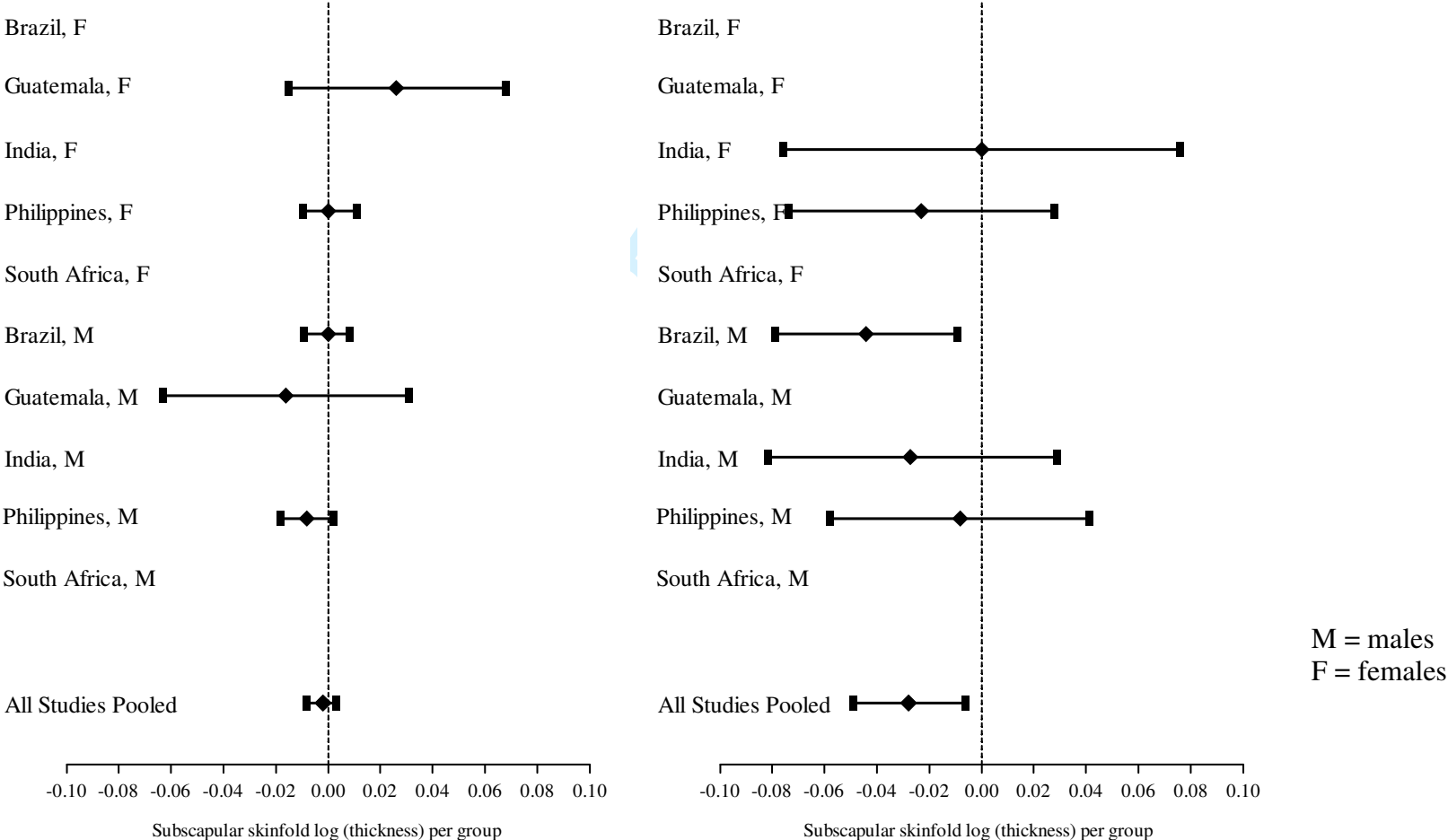


Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

Additional online material Figure N: Forest plots showing associations in each cohort between (a) duration of breastfeeding and (b) age of introduction of complementary foods and SUBSCAPULAR SKINFOLD

a) Duration of breastfeeding

b) Age of introduction of complementary foods



Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47