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

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ABSTRACT

Background Infant feeding patterns may influence lifelong health. This study tested the hypothesis that longer duration of breastfeeding and later introduction of complementary foods in infancy are associated with reduced adult cardiovascular risk.

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

Results There were no differences in outcomes between adults who were ever breastfed compared with those who were never breastfed. Duration of breastfeeding was not associated with adult diabetes prevalence or adiposity. There were U-shaped associations between duration of breastfeeding and systolic blood pressure and hypertension; however these were weak and inconsistent among the cohorts. Later introduction of complementary foods was associated with lower adult adiposity. BMI changed by -0.19 kg/m^2 (95%CI -0.37,-0.01) and waist circumference by -0.45 cm (95% CI -0.88,-0.02) per 3-month increase in age at introduction of complementary foods.

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

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Keywords: Infant feeding, breastfeeding, complementary feeding, blood pressure, diabetes, body composition.

INTRODUCTION

The World Health Organisation recommends exclusive breastfeeding from birth to 6 months, the introduction of nutritious complementary foods at 6 months, and continued breastfeeding for ≥2 years (1). Breastfeeding reduces morbidity and mortality from infection during infancy, and the timely introduction of nutritious complementary foods prevents stunting (2,3). Optimal infant feeding may also have long-term benefits. Adults and children who were breastfed have lower blood pressure, and lower rates of obesity and type 2 diabetes than those who were bottle-fed (4-8), with benefit proportionate to the duration of breastfeeding (9-14). This has been attributed to better appetite regulation and/or lower weight gain in breastfed infants, and/or effects of nutrients or bioactive constituents in breastmilk (6). Fewer studies have investigated long-term associations with the timing of initiation of complementary feeding, but lower rates of childhood obesity have been reported among those who started complementary foods later (15-17).

A limitation of the published evidence linking breastfeeding to later health is reliance on maternal recall of infant feeding practices, sometimes many years later (6-14). Few studies had data on duration of breastfeeding, and almost none had information on complementary feeding. The majority were conducted in high-income countries, where mothers who follow prescribed infant feeding guidelines tend to be from higher socio-economic and more educated groups (18,19). Associations of infant feeding with later adiposity and other risk factors are usually attenuated after adjusting for these confounding factors, suggesting that

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

In low- and middle-income countries (LMICs), breastfeeding tends to be the norm, but many mothers introduce complementary foods and stop breastfeeding too early (2). Obesity, diabetes and cardiovascular disease are rising rapidly in these countries (20). Promoting optimal infant feeding practices could be a low-cost intervention to improve lifelong health. Data from LMICs may help address confounding issues, because relationships between infant feeding practices and social class differ from those in high-income settings. The current study analyses data from the COHORTS collaboration (Consortium on Health Orientated Research in Transitional Societies) (21) comprising birth cohort studies in five LMICs. Our objective was to test the hypothesis that initial breastfeeding, longer duration of breastfeeding and later introduction of complementary foods are associated with lower adult blood pressure, glucose concentrations and adiposity.

SUBJECTS AND METHODS

Description of the cohorts

The collaboration among the five cohorts (Table 1) was originally established to contribute a paper for a Lancet series on Maternal and Child Nutrition (22). One author (CGV) approached the principal investigators of all follow-up studies in LMICs with ≥1000 subjects aged ≥15 years; all agreed to participate. The cohorts include the 1982 Pelotas (Brazil) Birth Cohort (23); the Institute of Nutrition of Central America and Panama Nutrition Trial Cohort (INTCS, Guatemala) (24); the New Delhi (India) Birth Cohort Study (25); the Cebu (Philippines) Longitudinal Health and Nutrition Survey (CLHNS) (26) and the Birth to

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Twenty (BTT - South Africa) cohort (27). The Guatemala cohort was based on a randomised controlled trial of protein-energy supplementation for the pregnant mothers of the cohort members, and for the cohort themselves as young children (24); the others were observational studies. All studies were approved by institutional research ethics committees, and participants gave informed consent.

Feeding data

The methods used to collect infant feeding data varied among the cohorts (Table 1). We defined complementary foods as semi-solid or solid foods. Variables used in the analysis were 1) whether an individual was ever breast fed (yes/no), available for all 5 cohorts, 2) total duration of breast feeding (9 categories from 0 to >24 months), available for all cohorts except India and 3) age at which complementary feeds were introduced (6 categories from <3 to >18 months), available for all cohorts except Guatemala.

Adult outcomes

Except for the South African participants who were adolescents (mean age 15 years) all others were young adults. For simplicity, these measures are referred to as “adult” outcomes.

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

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

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).

Body composition outcomes included body mass index (BMI, weight/height^2), waist circumference, body fat percentage, triceps and subscapular skinfolds, overweight (BMI ≥25 kg/m^2) and obesity (BMI ≥30 kg/m^2) (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).

Confounding variables

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

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

Missing data and final analysis sample

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

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

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

Statistical methods

Variables with skewed distributions were log transformed (glucose concentrations, skinfolds). Associations among feeding variables, potential confounders and adult outcomes were assessed within each cohort and in pooled data, using linear or logistic regression or Chi square tests. Categorized duration of breastfeeding and age at introduction of complementary foods were treated as continuous variables in linear regression models, and non-linear associations were tested using quadratic terms. Models were initially adjusted for age and sex only, and then for the set of confounding variables, adult BMI (not done for the adiposity outcomes) and height. Parameter estimates given in the text are fully adjusted. All pooled models were adjusted for cohort location and included interaction terms between cohort location and each confounding variable. We tested for heterogeneity of associations across the five sites by using (for continuous variables) F-tests from nested linear regression models and (for binary outcomes) Chi square tests based on the difference in deviance between nested models; where there was significant heterogeneity ($p<0.05$), we present data separately for each site. Sex differences were tested using interaction terms.

RESULTS

The number of participants included in this analysis, as a percentage of the original live births in each cohort, ranged from 19% in India to 75% in Brazil (Table 1). More than 90% of babies in all cohorts were initially breastfed (Table 2). The most frequent duration of

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

Predictors of infant feeding variables

Associations between the confounding variables and infant feeding variables are presented in additional online material Tables A-G. To summarise these data: in Brazil, women of lower SES/education were less likely to initiate breastfeeding, and tended to breastfeed for either a short or long duration (Tables A&B). In the Philippines and South Africa, women of lower SES/education were more likely to initiate breastfeeding and breastfed for longer. In Brazil, India and the Philippines, more affluent/educated mothers introduced complementary foods earlier. In Brazil and Guatemala women who breastfed for longer tended to be older (Table C). In Brazil and South Africa mothers who smoked (35% and 6% respectively) stopped breastfeeding earlier; the opposite association was seen in the Philippines (13%) (Table D). In Brazil and South Africa there were racial differences in feeding patterns (Table E). In the Philippines, rural mothers were more likely to initiate breastfeeding, breastfed for longer, and introduced complementary foods later (Table F). Babies who were breastfed for a shorter duration tended to have lower birthweight in all cohorts (Table G); in Brazil and India, babies who started complementary foods earlier had higher birthweight.

Mean age at adult follow-up ranged from 16 years (South Africa) to 32 years (Guatemala) (Table 3). The prevalence of hypertension ranged from 1% (Philippines, females) to 17% (Brazil, males), of diabetes from <1% (Philippines and South Africa) to 4% (Brazil and India, males) and of obesity from 1% (Philippines, females) to 25% (Guatemala, females).

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Ever v never breastfed

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

Breastfeeding duration

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

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shaped associations between breastfeeding duration and any blood pressure outcome.

There was no heterogeneity among the cohorts for glucose or body composition outcomes. There was a U-shaped association between breastfeeding duration and IFG+DM (Table 4), and an inverse association between breastfeeding duration and adult skinfold thickness (Table 5). However, these associations were attenuated after adjusting for confounding variables.

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

Introduction of complementary foods

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

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) respectively per category increase in age of introduction of complementary foods. When the analysis was limited to the period up to 6 post-natal months, these associations were attenuated; BMI, waist circumference and subscapular skinfold thickness fell by 0.21 (95% CI -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-month category.

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

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

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

DISCUSSION

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

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breastfeeding and adult blood pressure, with the lowest mean systolic blood pressure among those breastfed for 3-6 months; however these were small and inconsistent effects. After adjusting for confounding factors, there were no associations between duration of breastfeeding and adult glucose concentrations, DM+IFG or body composition. Participants who started complementary foods later in infancy were less adipose and overweight in adult life. These associations were robust to adjustment for the set of confounding variables, but attenuated by adjustment for 2-year weight.

Strengths of the study were that infant feeding data were collected prospectively, reducing the risk of misclassification due to inaccurate maternal recall, and included duration of breastfeeding and introduction of complementary foods. Limitations were missing infant feeding data and losses to follow-up in the older Guatemala and India cohorts. Missing data would influence population means and prevalence values for both exposures and outcomes, but the within-cohort associations of interest, between infant feeding and adult outcomes, would be less vulnerable to bias. Associations of duration of breastfeeding and age of introduction of complementary foods were little changed if the Guatemala and India cohorts were excluded from the relevant analyses. A further limitation of the study was heterogeneity among the cohorts in the methods for recording infant feeding data. This reduced the number of exposures we could include (for example, exclusive breastfeeding and predominant breastfeeding were definable in only 1 and 3 of the cohorts respectively and were not included), and we defined introduction of complementary feeds as the introduction of solids rather than nutritious liquids and solids, the more generally used definition. The different methods would tend to reduce the precision of the exposure variables and thus attenuate any estimates of association with adult outcomes. The methods used for measuring adult outcomes also varied among the cohorts, although are all accepted techniques for

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

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

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year weight, suggest that this could be a mediating factor.

There were no differences in outcomes between 'ever' versus 'never' breastfed groups. This contrasts with results from meta-analyses of observational studies, mainly in high-income settings, which have shown lower systolic (around -1 mmHg) and diastolic blood pressure (<-0.5 mmHg), a 30-40% lower risk of type 2 diabetes and a 20% lower risk of overweight or obesity in children or adults who were breastfed (6-9). Possible explanations for our negative findings are that initiation of breastfeeding was almost universal in these cohorts (hence reducing power), and/or that the associations in the above studies result from residual confounding, not seen in our cohorts because of the different relationships between infant feeding and maternal SES.

There were U-shaped associations between duration of breastfeeding and blood pressure outcomes. These trends were inconsistent among the 5 cohorts (Figure 1). Overall, there was no evidence that longer duration of breastfeeding protects against the later development of hypertension or diabetes. Again, these findings differ from those reported from high-income settings, where most studies (9,10,12,53,54), though not all (55,56), found lower blood pressure and/or a lower risk of type 2 diabetes in children or adults who were breastfed for longer. Explanations could be, again, residual confounding in high-income populations; imprecision in the exposure measure due to different data collection methods; or differences in other post-natal factors related to the adult outcomes, for example childhood growth, between low- and high-income populations.

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

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

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

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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.

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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

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New Delhi, India[24]	Prospective cohort	1969-1972 8,181	1998-2002 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 highest 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 Philipp-ines[25]	Prospective cohort	1983-1984 3,080	2005 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 3,273	2005 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.

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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		104	(5.1)	81	(5.7)
0.01-1.00	997	(23.2)	2	(0.3)	data		120	(5.9)	103	(7.3)
1.01-3.00	1282	(29.8)	2	(0.3)	on		113	(5.5)	207	(14.6)
3.01-6.00	621	(14.4)	12	(1.8)	duration		134	(6.6)	145	(10.2)
6.01-9.00	290	(6.7)	39	(5.8)	of		106	(5.2)	94	(6.6)
9.01-12.00	164	(3.8)	60	(8.9)	breast		163	(8.0)	110	(7.8)
12.01-18.00	176	(4.1)	258	(38.1)	feeding		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		0	(0.0)	117	(5.9)	922	(58.3)
3.01-6.00	1167	(28.2)	data		6	(1.0)	1630	(81.7)	592	(37.4)
6.01-9.00	81	(2.0)	on		50	(8.3)	238	(11.9)	53	(3.4)
9.01-12.00	22	(0.5)	age		254	(42.2)	10	(0.5)	12	(0.8)
12.01-18.00	0	(0.0)	complementary		220	(36.5)	0	(0.0)	1	(0.1)
> 18.00	0	(0.0)	foods		72	(12.0)	0	(0.0)	1	(0.1)
Data missing (N)	302		introduced		924		53		39	

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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)
Blood Pressure Outcomes										
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
Glucose Outcomes										
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
Body Composition										
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**

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

	Model 1			Model 2			
	Effect Size			Effect Size			
	B	OR	95% CI	B	OR	95% CI	p-het
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.

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

	Model 1			Model 2			
	Effect Size			Effect Size			
	B	OR	95% CI	B	OR	95% CI	p-het
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.

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

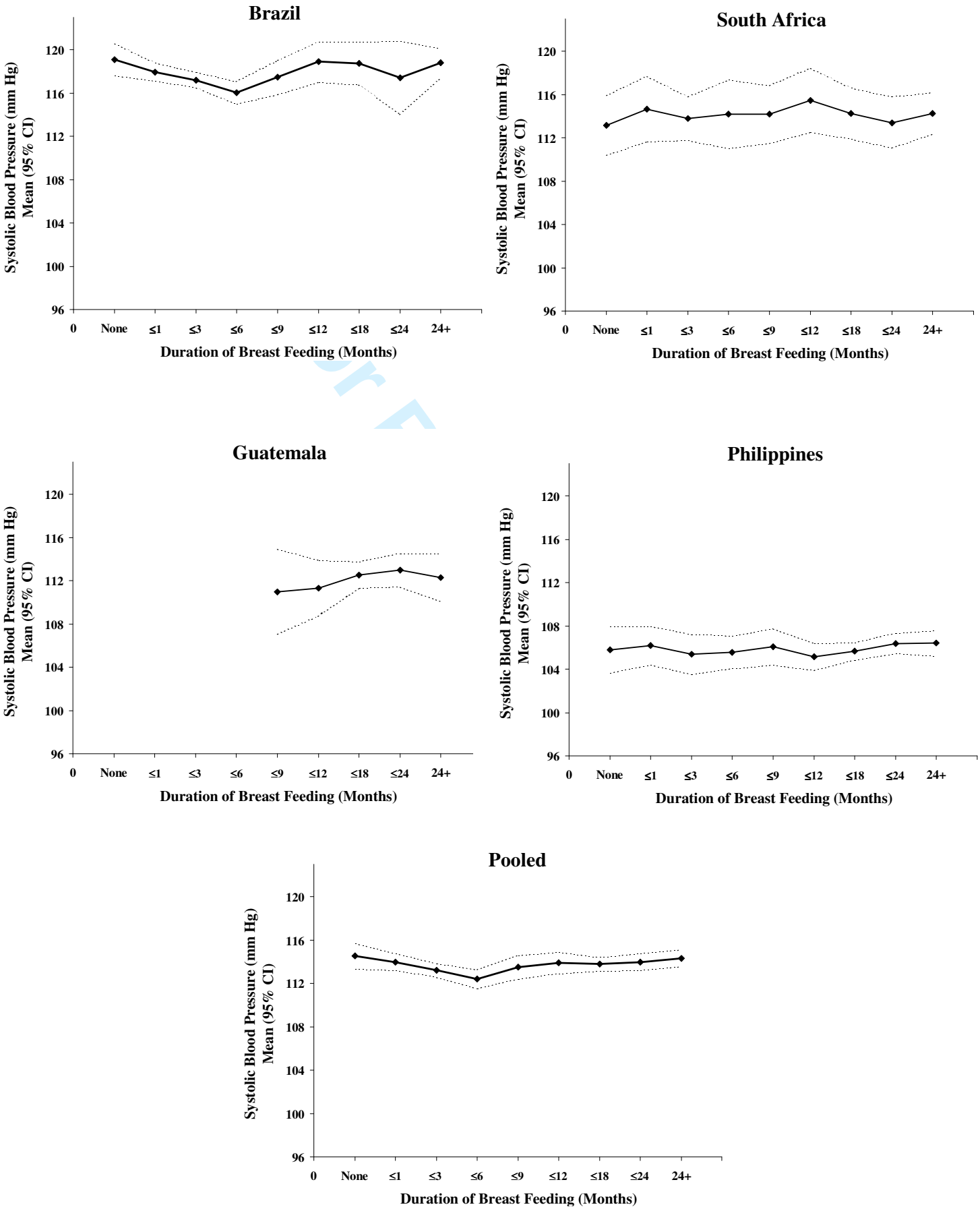
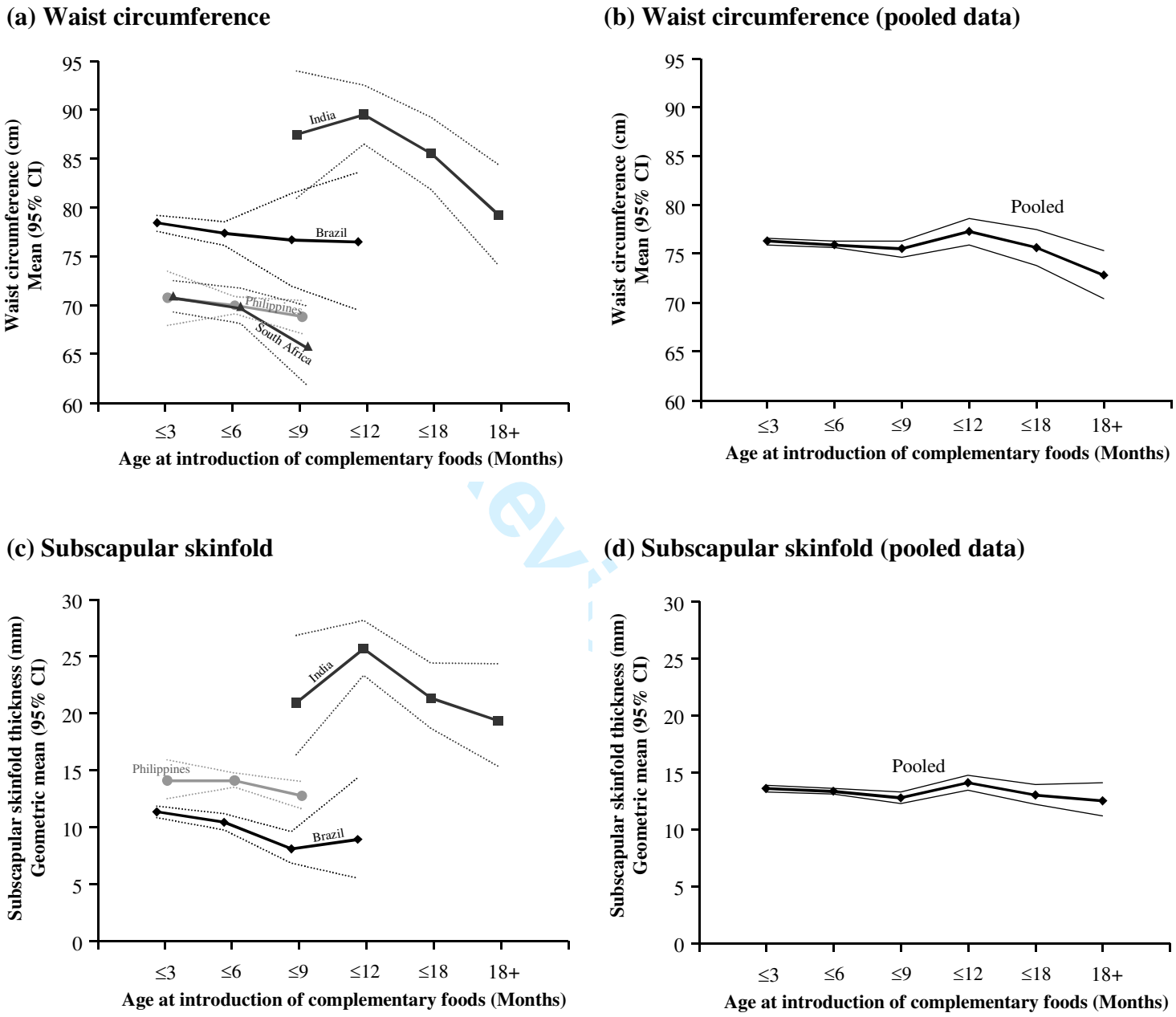


Figure 2 Associations of age of introduction of complementary foods with adult waist circumference (a and b), and subscapular skinfold measurement (c and d) (fully adjusted models) in the four cohorts with available data separately and pooled



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						3	3	4	7	13	8	6	5	10	8
1.01-3.00	28	30	34	33	23	1	0	0	0	1						4	4	4	7	9	10	13	17	15	22
3.01-6.00	11	14	16	15	21	1	2	2	0	3						4	4	6	10	9	9	8	12	10	13
6.01-9.00	6	6	6	13	15	5	7	8	4	3						3	5	7	5	7	4	7	6	8	14
9.01-12.00	2	4	3	5	7	6	7	8	10	7						6	7	9	9	9	7	8	6	10	9
12.01-18.00	5	4	4	5	4	35	41	50	38	27						35	30	28	24	20	15	13	16	12	8
18.01-24.00	1	1	1	1	1	37	28	24	30	30						27	24	23	21	14	12	17	13	9	4
>24.00	11	9	7	7	5	15	16	8	16	28						16	21	16	11	9	29	24	21	18	15
N			4280					638										2038					1419		
p^{hetero}			<0.001					0.01										<0.001					<0.001		
p^{linear}			0.6					1.0										<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						0	0	0	1	3	81	84	84	79	81	38	32	35	42	50
6.01-9.00	4	2	2	0	0						0	2	6	11	8	14	13	11	12	9	3	5	3	2	4
9.01-12.00	1	0	0	0	0						33	47	43	40	45	0	0	1	1	1	1	1	0	1	0
12.01-18.00	0	0	0	0	0						58	34	38	37	33	0	0	0	0	0	0	0	0	0	0
>18.00	0	0	0	0	0						8	17	13	11	10	0	0	0	0	0	0	0	0	0	0
N			4125										602					1995					1581		
P^{hetero}			<0.001										0.2					0.001					0.06		
P^{linear}			<0.001										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.

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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.

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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.

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<u>Additional online material</u> 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.

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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.

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<u>Additional online material</u> 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.

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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

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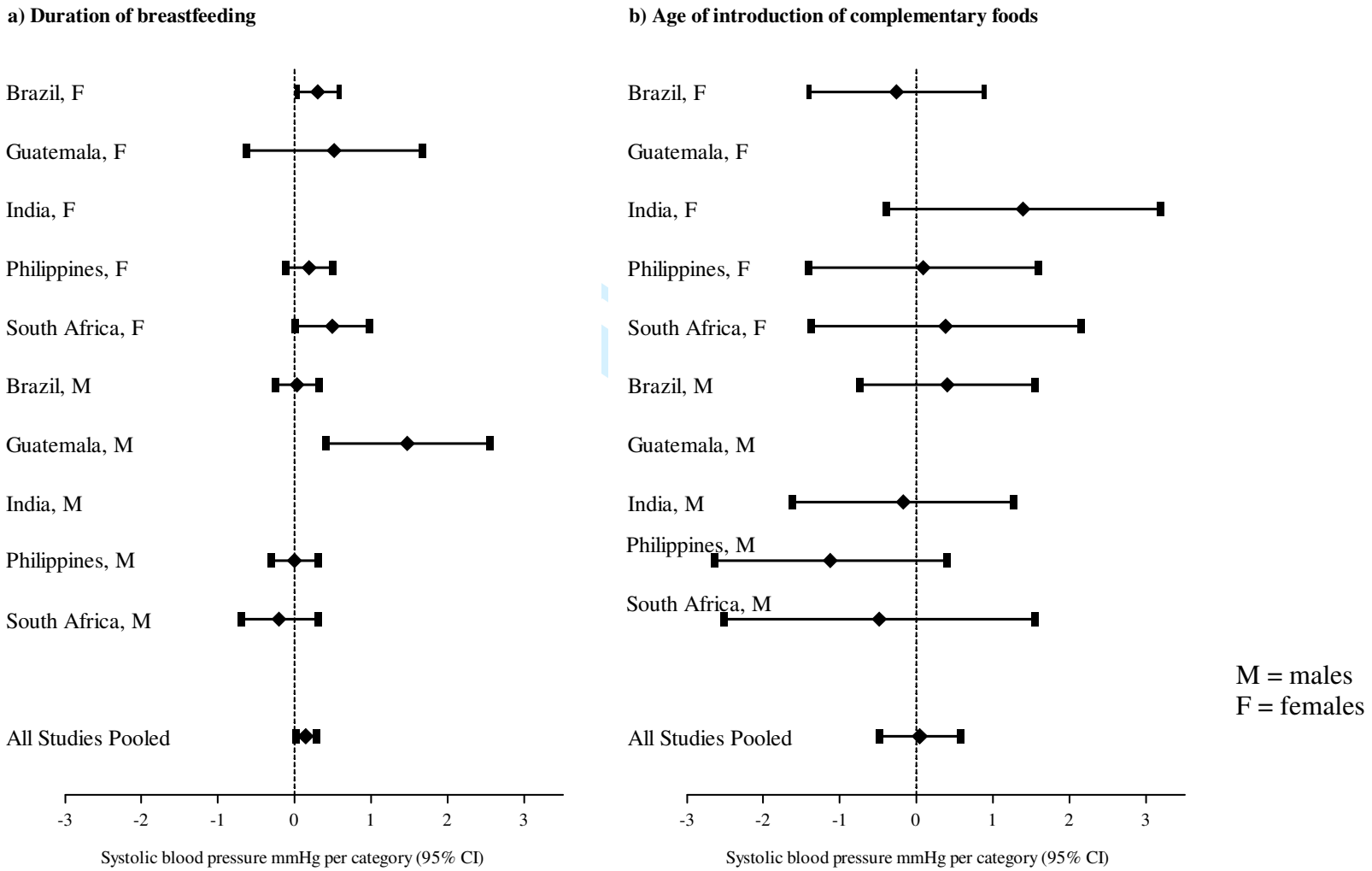
Additional online material Table H Infant feeding patterns and weight at age two years

	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

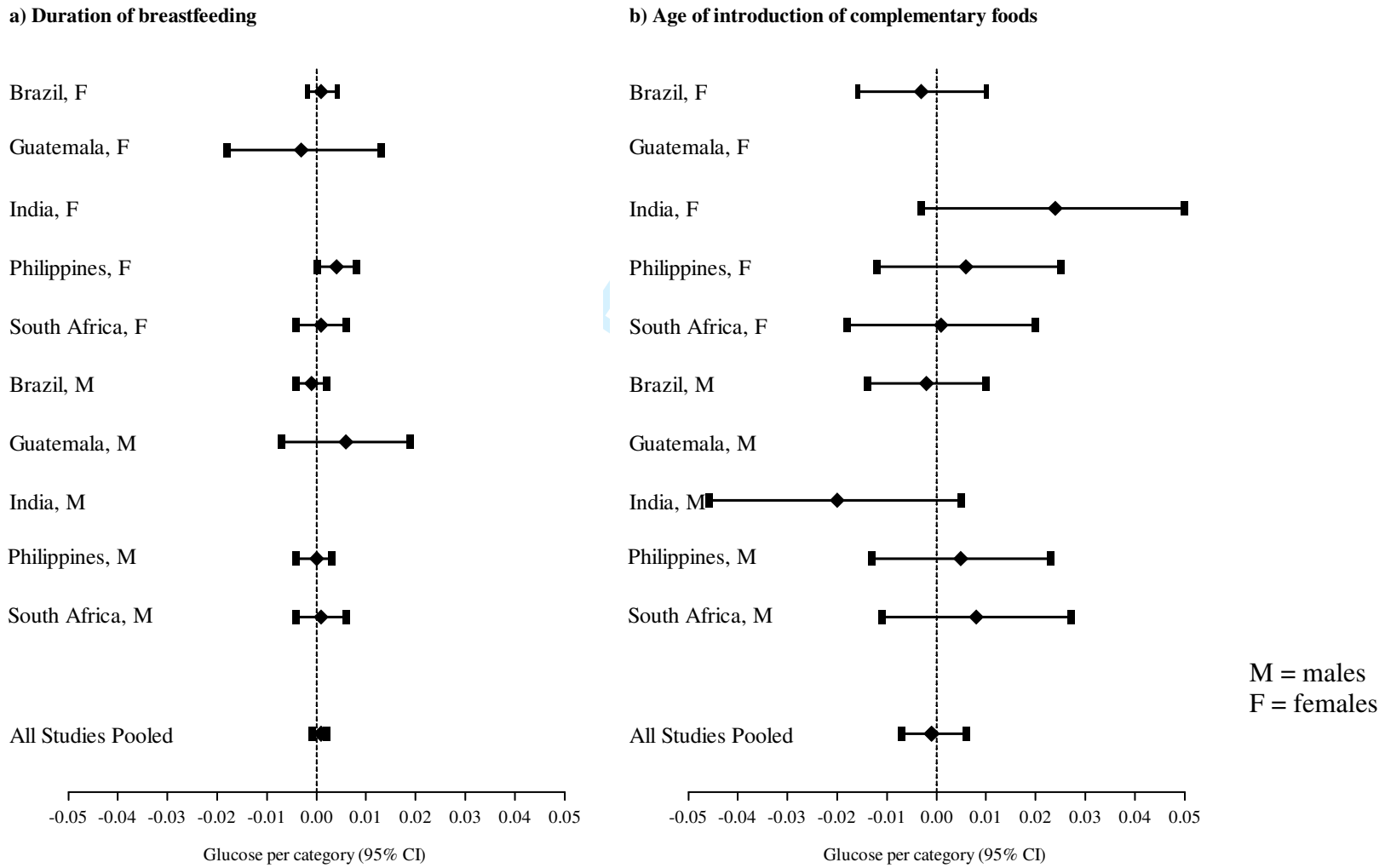
For Review Only

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



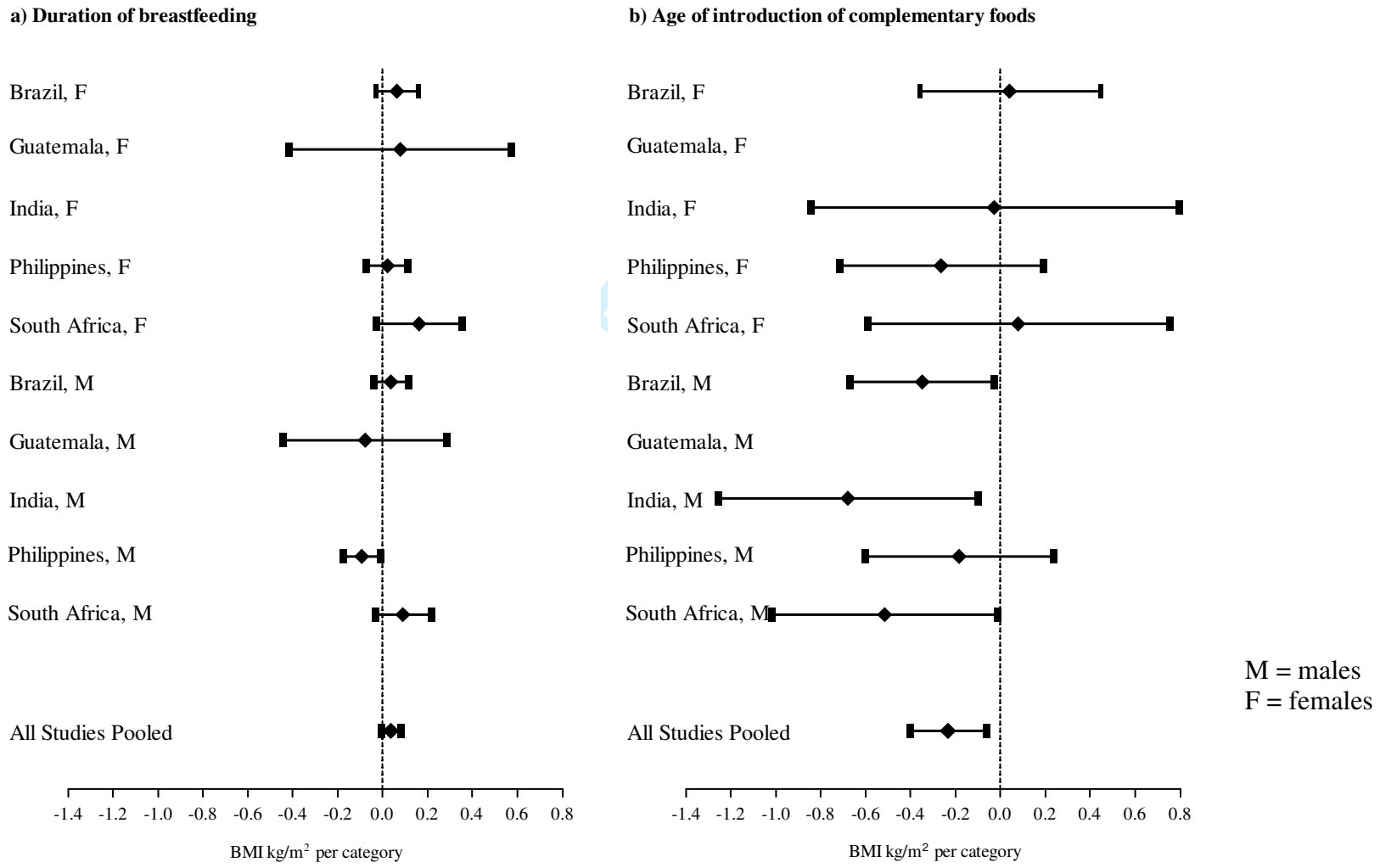
Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

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



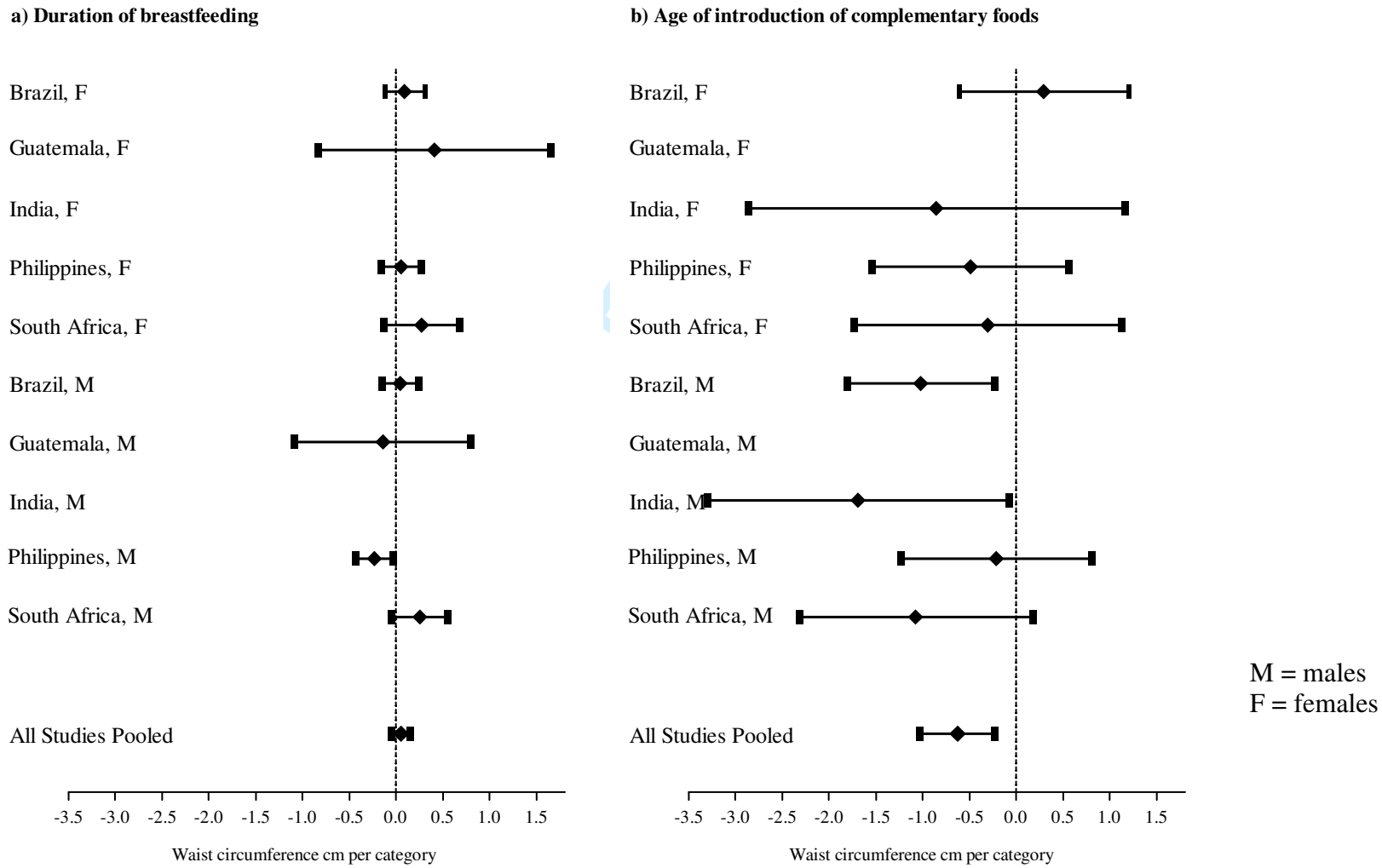
Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

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



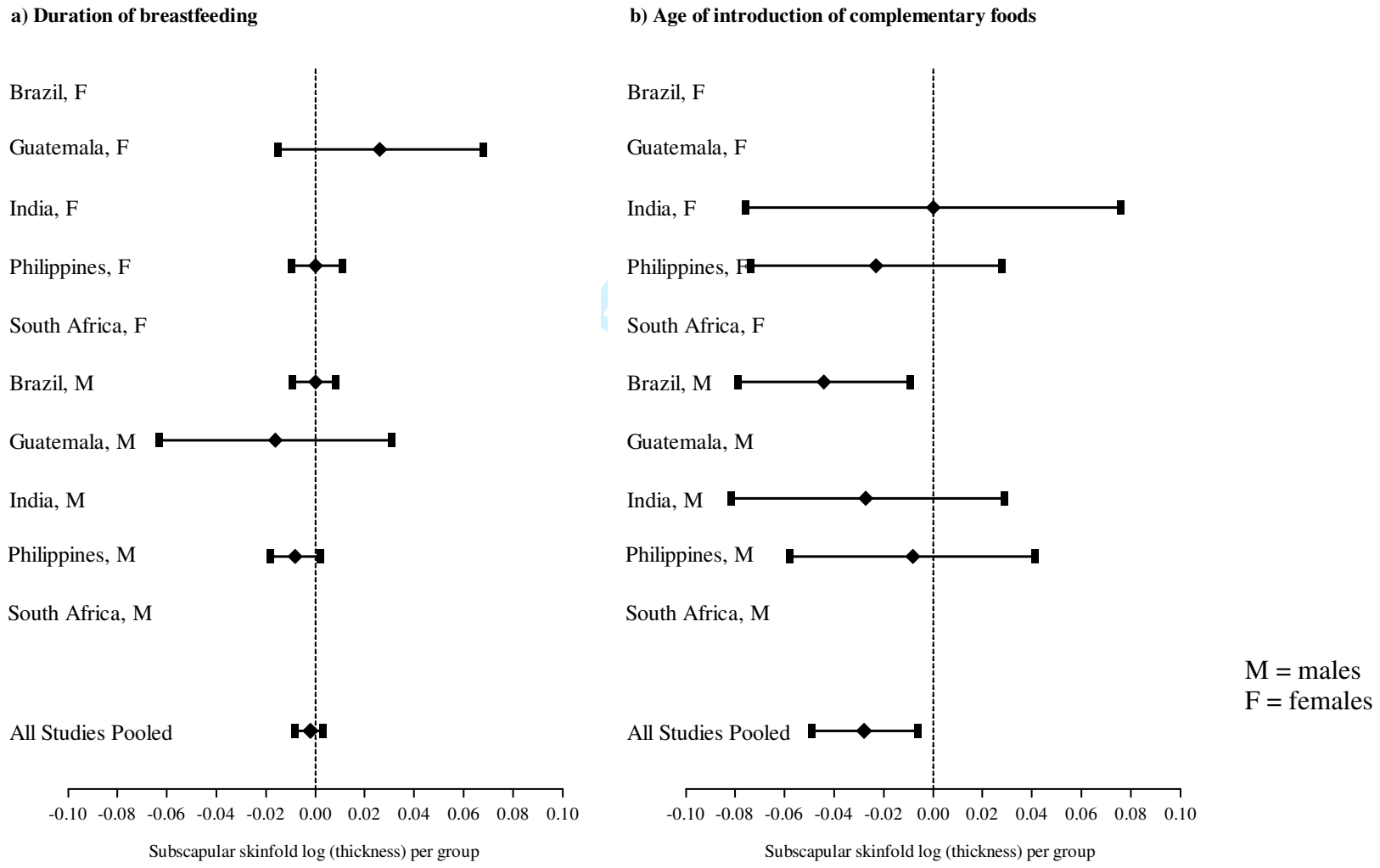
Analyses adjusted locally for mother's education, socio-economic status, smoking, age, race, urban/rural status, subject's age and birthweight

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



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



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