Public Health Nutrition: 20(14), 2523–2536 doi:10.1017/S1368980017001720

Maternal employment and childhood overweight in low- and middle-income countries

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Submitted 14 January 2017: Final revision received 16 May 2017: Accepted 16 June 2017: First published online 4 August 2017

Abstract

Objective: To investigate the association between maternal employment and childhood overweight in low- and middle-income countries (LMIC).

Design/Setting: We utilized cross-sectional data from forty-five Demographic and Health Surveys from 2010 to 2016 (*n* 268 763). Mothers were categorized as formally employed, informally employed or non-employed. We used country-specific logistic regression models to investigate the association between maternal employment and childhood overweight (BMI *Z*-score > 2) and assessed heterogeneity in the association by maternal education with the inclusion of an interaction term. We used meta-analysis to pool the associations across countries. Sensitivity analyses included modelling BMI *Z*-score and normal weight (weight-for-age *Z*-score ≥ − 2 to <2) as outcomes.

Subjects: Participants included children 0–5 years old and their mothers (aged 18–49 years).

Results: In most countries, neither formal nor informal employment was associated with childhood overweight. However, children of employed mothers, compared with children of non-employed mothers, had higher BMI *Z*-score and higher odds of normal weight. In countries where the association varied by education, children of formally employed women with high education, compared with children of non-employed women with high education, had higher odds of overweight (pooled OR = 1·2; 95 % CI 1·0, 1·4).

Conclusions: We find no clear association between employment and child overweight. However, maternal employment is associated with a modestly higher BMI *Z*-score and normal weight, suggesting that employment is currently associated with beneficial effects on children's weight status in most LMIC.

Keywords
Maternal employment
Childhood overweight
BMI *Z*-score
Low- and middle-income countries
Nutrition transition

Longitudinal studies from the USA and Canada have demonstrated an association between maternal employment and increased risk of childhood overweight[1–4]. Moreover, increasing maternal employment between 1968 and 2001 has been estimated to account for 10 % of the overall increase in overweight prevalence among children during this time period[5]. Maternal employment has also increased in low- and middle-income countries (LMIC). Over the past two decades, women's participation in the labour force has increased by 15 percentage points and, on average, 50 % of women in LMIC are currently employed[6–8]. This increase coincides with an increase in childhood overweight in LMIC. Between 1990 and 2010, overweight prevalence among children aged 0–5 years increased from 4 to 6 %[9]. It is hypothesized that initially maternal employment in LMIC may be protective against undernutrition, since additional income may be allocated towards meeting children's basic energy needs[10]. Although maternal employment can have positive impacts on households, as the economies in LMIC develop, there may also be unintended consequences for childhood obesity risk in LMIC, paralleling those observed in high-income countries.

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Prior research provides some hypotheses on the mechanisms of the maternal employment–childhood overweight association. For example, one study indicated that the presence of a working mother was associated with increases in daily food intakes and total weekly expenditures[11]. However, as LMIC undergo their nutrition transitions and food environments and preferences change, lower- and middle-income households may use their income earned from employment to purchase energy-dense foods, which could increase the risk for childhood overweight[12,13]. Du *et al.* demonstrated that there is a positive income elasticity (i.e. the quantity demanded of a good, relative to change in income) for high-fat and animal-source foods, suggesting that high-fat and animal-source foods are increasingly consumed among low-income groups in LMIC as country-level gross domestic product (GDP) increases[14]. Similarly, portion sizes and the purchase of ultra-processed foods have increased and traditional diets are being supplemented with liberal amounts of oils[15]. Maternal employment may also have effects on maternal time allocation that could increase child overweight risk[11,16]. For example, working mothers may alter their preference towards more easily prepared foods or breast-feed for a shorter period of time[11,17]. Despite evidence suggesting that there are plausible mechanisms through which maternal employment could now be associated with child overweight in LMIC, only one prior study examines this relationship. Results from a small sample (forty-three children) in South Africa, an upper middle-income economy, suggested that children of working mothers had an eighteenfold higher odds of being overweight[18].

The primary aim of the present study was to address key gaps in the literature by testing the hypothesis that maternal employment is associated with higher odds of overweight among children aged 0–5 years in LMIC, using the most recent data available from forty-five countries. Evaluating overweight risk among young children is important for several reasons. First, although the current public health burden of overweight among children aged 0–5 years in LMIC is lower than in high-income countries, overweight prevalence in this age group has increased by 65 % in the past 20 years and is expected to increase further[9,19–22]. Second, size tends to track through the life course as infants defined as obese or who are at the highest end of the distribution for BMI are more likely to be obese at later life stages[22–27]. Childhood overweight also has adverse consequences on adulthood cardiometabolic morbidity[22,23,28]. The secondary aim of the present study was to assess heterogeneity in the association between employment and childhood overweight by maternal education level, as prior literature suggests that the relationship between maternal employment and child nutritional status varies by maternal education and that women with higher educational attainment more often participate in formal sector employment[1,4,29,30]. A better understanding of the relationship between maternal employment and childhood overweight in LMIC is critical given the long-term adverse health consequences associated with childhood overweight and the potential need for additional policies designed to support women in the workplace[22,23,28].

Methods

Data source and population

We utilized cross-sectional data from the Demographic and Health Surveys (DHS). The DHS are standardized, allowing for cross-country comparisons, and employ a multistage cluster sample design that is nationally representative[31].

We utilized one survey per country from forty-five LMIC that met the following inclusion criteria: (i) it was the most recent survey administered between 2010 and June 2016; (ii) women were queried on their employment status; and (iii) the survey contained child anthropometrics. Four countries that had data available between 2010 and June 2016 were excluded because they did not have child anthropometrics. We included women, aged 18–49 years, who had at least one child aged 0–5 years (~45 % had one child, ~55 % had two or more children). Children residing outside the household were excluded (n 14 832 (3·5 %) across all forty-five countries). Our final analytic sample included 268 763 children from 121 917 mothers.

Our sample was limited to 0–5-year-old children, since: (i) this is the age range for which DHS routinely collects child anthropometry; and (ii) evaluating overweight risk among young children is important because childhood overweight has adverse consequences on risk of overweight and cardiometabolic morbidity at later life stages[22,23,28].

Dependent variables

Overweight or obese (henceforth referred to as 'overweight'), defined as BMI Z-score >2, served as our primary dependent variable[32]. Overweight was defined based on the age- and sex-specific 2006 WHO Child Growth Standards[33]. Individual-level weight (in kilograms) and length/height (length if the child was <2 years old; measured in centimetres) were measured by trained technicians[34].

Primary independent variable

We modelled maternal employment as a three-category variable, namely formally employed, informally employed or non-employed, based on research indicating that: (i) many women employed in LMIC are engaged in informal employment; (ii) wages are more than 50 % lower in the informal sector; and (iii) the maternal employment–overweight relationship varies by the number of hours women work[1,29,30,35]. We describe women not participating in the labour force as 'non-employed' because this term includes persons who choose to not seek employment; 'unemployed' was not used because the term describes persons without jobs who are actively seeking employment[36].

Employment type was defined based on the following four indicators: (i) employment status in the last 12 months (employed, non-employed); (ii) aggregate occupation category (skilled, unskilled; see online supplementary material, Supplemental Table 1); (iii) type of earnings (cash only, cash and in-kind, in-kind only, unpaid); and (iv) seasonality of employment (all year, seasonal/occasional employment). Formal employment included the following combinations: (i) employed, skilled occupation, cash-only earnings, employed all year; (ii) employed, skilled occupation, cash-only earnings, seasonal/occasional employment; and (iii) employed, unskilled occupation, cash-only earnings, employed all year. Other employed women were categorized as informally employed (see Supplemental Table 1).

Confounders and effect measure modifiers

We identified confounding factors *a priori* using a directed acyclic graph, which is a causal diagram used to characterize the relationship among variables thought to influence the primary independent and the dependent variables based on both theorized and documented relationships (see Fig. 1)[37]. In all models, confounders included maternal age (years), marital status (married or living together *v.* single, widowed, divorced), number of household members (a continuous variable), child's age (months), child's sex, and living with ones' mother, mother-in-law or sister (as a proxy variable for childcare support).

Based on prior literature suggesting that (i) the employment–nutritional status relationship varies by maternal educational attainment and (ii) education may be a determinant of participation in formal *v.* informal sector employment, we tested for effect modification by maternal education by including an interaction term[1,4,29,30,38]. We hypothesized *a priori* that within the formal or informal sector, better-educated, more skilled mothers are likely to have higher-skilled occupations that contribute to their sense of self-worth, improve decision-making power and increase their efficiency of time use, which could facilitate high-education mothers, compared with low-education mothers, differentially prioritizing health and nutrition[39,40]. Less-educated mothers likely have lower-skilled jobs, within the formal or informal sector, and co-workers who may be less knowledgeable about health-promoting nutrition practices and therefore less likely to share ideas regarding nutrition. Additionally, mothers with lower educational attainment may enter the workforce out of necessity, whereas mothers with higher educational attainment may do so voluntarily. This is generally consistent with Goldin's hypothesis, which proposes a U-shaped relationship between country level of economic development, coinciding with an increase in average educational attainment, and

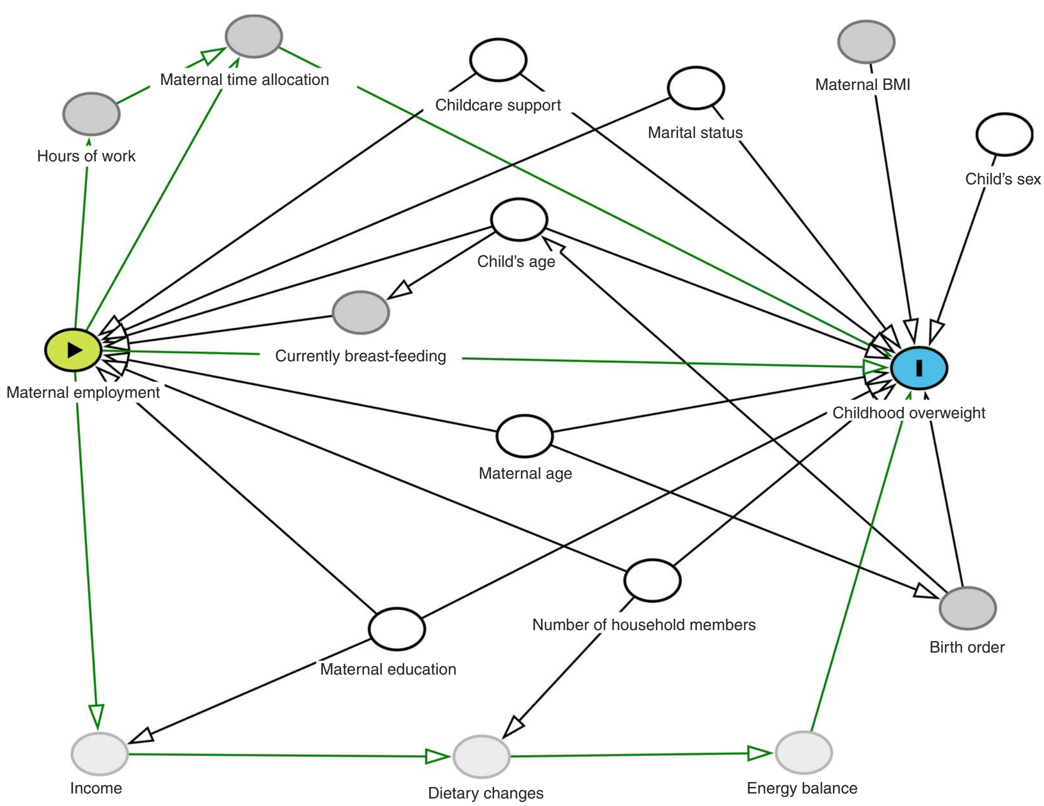

Fig. 1 Directed acyclic graph for the association between maternal employment and childhood overweight: ⊙, exposure; ⊙, outcome; ○, adjusted variable; ○, unobserved (latent) variable; ○, other variable; ━, causal path. Birth order was highly collinear with child's age. Therefore, we controlled for child's age in our primary models.

labour force participation[41]. Goldin's hypothesis suggests that women's participation is highest in low-income countries, where average educational attainment is lower and women work out of necessity. In lower middle-income countries, female labour force participation is lower; the bottom of the U-shape occurs in countries with incomes of about $US 2500 per capita (in 1980) and is thought to be due in part to relatively lower wages for agriculture-based jobs in these countries. In these contexts, the opportunity costs of employment may not outweigh the perceived benefits of remaining at home. As economic development continues to increase (i.e. countries transition to upper middle-income or high-income), education levels rise and women re-enter the work force to take advantage of relatively skilled jobs as they emerge. Across all LMIC in this sample, approximately 50 % of women had less than a primary level of school completed. Therefore, education was modelled as a binary variable, with low education defined as less than a primary level of education completed and high education defined as at least primary school completed.

We hypothesized that the employment–overweight association would vary by countries' stage in the nutrition transition because the socio-economic gradient of overweight prevalence shifts as countries economically develop[42]. We explored differences in the country-level associations by log (GDP per capita), adjusted for purchasing power parity and percentage urban, both theorized drivers of the nutrition transition[12]. These data were obtained from the World Development Indicators database, corresponding to the survey year[43]. GDP per capita was log-transformed to reflect the expected influence of a percentage increase (e.g. 10 %), rather than an absolute dollar increase (e.g. $US 10). Percentage urban was defined as the number of people living in urban areas divided by the total population.

Statistical analyses

Within-country analyses

We employed separate multivariable logistic regression models for each country to test the association between maternal employment and childhood overweight. Taylor-series linearized SE accounted for the clustered design and we utilized DHS sampling weights to account for differential probability of selection and response.

With the inclusion of an interaction term, we tested for effect modification in the maternal employment–child overweight association by maternal educational attainment in our primary models, using a *post hoc* Wald test. We retained the interaction term only if it was statistically significant (*n* 7). In countries where the association did not vary by education (*n* 38), education was included as a confounder.

Between-country analyses

After obtaining disaggregated estimates for each country, coefficients for the employment–overweight associations were entered into a meta-analysis to obtain OR pooled across countries. Random-effects meta-analysis, used to generate pooled OR (POR), is the statistical combination of the estimates from separate countries (i.e. it utilizes the country-specific β coefficient) and assumes that the magnitude of the association between employment and overweight may differ by country. We estimated POR for three subgroups: (i) children in countries where the association did not vary by maternal education; (ii) children of women with low educational attainment in countries where the association varied by maternal education; and (iii) children of women with high educational attainment in countries where the association varied by education. Additionally, country-specific β coefficients were entered into a random-effects meta-regression in order to assess whether the association between employment and child overweight varied by country-level log(GDP) and percentage urban[44].

Sensitivity analyses

Sensitivity analyses included modelling BMI *Z*-score (measured continuously) and at-risk-of-overweight (BMI *Z*-score > 1) as the outcomes. We also modelled underweight (weight-for-age *Z*-score (WAZ) < −2) and normal weight (defined both as WAZ ≥ −2 to <2 and BMI *Z*-score ≥ −2 to <2) as outcomes to assess whether the results were consistent with the outcome of overweight. Additional robustness checks included: (i) excluding wasted children (BMI *Z*-score < −2) from the analysis; (ii) stratifying results based on child's age (≤24 months *v.* >24 months); (iii) controlling for birth order; and (iv) controlling for maternal BMI. We also assessed our results when including current breast-feeding status (yes/no) as a covariate, which we hypothesize could influence mothers' entry into the workforce. We was set α to 0·05 for main effects and to 0·10 for interaction terms[45,46]. Analyses were performed using the statistical software package Stata version 14.1.

Results

Overall, 23 % of mothers were formally employed and 32 % of mothers were informally employed. The mean age for children was 1·9 (SD 1·4) years and 47 % had a mother with at least a primary level of education (Table 1). Most formally employed women (61 %) had a high level of education, compared with 32 % of informally employed women and 50 % of non-employed women (see online supplementary material, Supplemental Table 2). Children of formally and informally employed women had a similar prevalence of overweight (6 %), but prevalence rates across countries were wide-ranging (Table 1).

Formal employment was associated with higher odds of childhood overweight in three countries (Egypt, Ghana, Kenya) and lower odds of overweight in three other countries (Nigeria, Pakistan, Yemen; Figs. 2 and 3).

Table 1 Demographic characteristics of children in selected low- and middle-income countries*

										Overweight†,‡			
		Maternal age (years)		Mother with at least primary education		Child's age (years)		Birth order		Formal employment		Informal employment	
Country (year)	*N*	Mean	SD	*n*	%	Mean	SD	Mean	SD	*n*	%	*n*	%
Armenia (2010)§	1328	26·9	4·8	1229	95	1·9	1·4	1·8	0·9	29	15	4	9·6
Bangladesh (2014)	6439	26·0	5·6	4443	67	2·0	1·4	2·3	1·5	15	0·97	7	2·5
Burkina Faso (2010)	6455	29·4	6·8	468	7·1	2·0	1·4	3·9	2·4	35	3·8	175	3·9
Burundi (2010)	3385	30·3	6·7	754	22	1·9	1·4	3·8	2·4	5	3·9	133	4·3
Cambodia (2014)	4314	28·6	5·9	1914	44	1·9	1·4	2·2	1·5	54	3·0	26	1·8
Cameroon (2015)	4944	28·4	6·6	2377	48	1·9	1·4	3·7	2·4	129	8·6	205	9·1
Chad (2014)	9873	28·4	6·6	1450	15	2·0	1·4	4·4	2·6	40	3·7	170	4·3
Colombia (2010)‖	15 369	28·0	6·6	11 733	86	2·0	1·4	2·3	1·6	255	5·2	200	5·9
Comoros (2012)	2226	30·0	6·6	791	34	1·9	1·4	3·6	2·4	45	10	49	11
Congo (2011)	4289	28·8	6·7	2550	70	1·8	1·4	3·2	2·0	66	4·2	44	4·3
Côte d'Ivoire (2012)	3110	29·0	6·8	460	16	1·8	1·4	3·6	2·3	32	4·0	63	4·5
DRC (2014)	7988	29·5	6·7	3627	46	2·0	1·4	4·0	2·5	72	6·2	279	5·4
DR (2013)	3050	27·5	6·1	2254	76	1·9	1·4	2·3	1·4	116	8·7	24	8·5
Egypt (2014)	14 267	28·6	5·5	10 989	77	1·9	1·4	2·4	1·4	308	20	75	21
Ethiopia (2011)	9527	29·3	6·5	518	5·2	2·0	1·4	4·0	2·6	38	3·1	93	2·3
Gabon (2012)	3229	29·4	6·8	1945	73	1·8	1·4	3·3	2·2	70	7·5	43	9·7
Gambia (2013)	3097	29·3	6·6	927	31	1·8	1·4	3·7	2·3	40	5·3	25	2·5
Ghana (2014)	2604	30·8	6·7	1462	58	1·9	1·4	3·3	2·1	52	4·5	20	2·1
Guinea (2012)	2973	29·1	7·1	337	11	2·0	1·4	3·8	2·3	39	5·5	82	4·8
Haiti (2012)	3932	29·7	7·0	1528	41	1·8	1·4	3·1	2·3	42	3·8	59	5·0
Honduras (2012)	9531	27·9	6·5	5801	65	2·0	1·4	2·7	2·0	186	6·9	78	5·0
Kenya (2014)	8806	28·9	6·3	4683	58	2·0	1·4	3·3	2·3	170	6·5	139	4·7
Kyrgyz Republic (2012)§	3989	28·8	6·0	3267	88	1·9	1·4	2·4	1·4	62	8·5	9	7·2
Lesotho (2014)	1239	27·7	6·5	950	78	1·8	1·4	2·4	1·6	28	9·6	16	8·6
Liberia (2013)	3110	29·0	7·1	823	31	1·9	1·4	3·6	2·3	36	4·9	33	3·6
Malawi (2010)	4518	28·5	6·6	1039	23	2·0	1·4	3·6	2·3	83	13	338	13
Mali (2013)	3666	29·0	6·7	340	9·2	2·0	1·4	3·8	2·3	14	3·3	33	3·0
Mozambique (2011)	9237	29·1	7·1	1553	16	1·9	1·4	3·7	2·3	87	11	411	11
Namibia (2013)	1734	29·6	7·0	1214	76	1·7	1·4	2·9	2·0	37	7·1	7	4·6
Nepal (2011)	2252	26·9	6·0	880	38	2·0	1·4	2·6	1·8	4	1·8	21	1·4
Niger (2012)	4838	29·3	6·7	270	5·3	2·0	1·4	4·6	2·7	18	3·3	24	3·1
Nigeria (2013)	24 755	29·6	6·8	11 736	47	2·0	1·4	3·9	2·5	674	5·0	281	6·4
Pakistan (2013)	3225	29·2	6·0	1308	38	2·0	1·4	3·5	2·4	12	2·3	23	4·4
Peru (2012)¶	9030	29·9	6·9	6691	81	2·0	1·4	2·6	1·8	328	8·5	82	4·8
Rwanda (2014)	3529	30·4	6·3	1236	35	1·9	1·4	3·0	2·1	78	14	280	10
Senegal (2014)	5937	29·9	6·8	713	13	1·9	1·4	3·6	2·3	30	1·9	21	1·4
Sierra Leone (2013)	4197	29·7	7·1	847	20	1·9	1·4	3·7	2·3	89	13	309	11
Tajikistan (2012)	4541	27·9	5·6	4466	95	1·9	1·4	2·5	1·6	50	11	64	8·3
Tanzania (2010)	6709	29·4	6·8	4053	60	1·9	1·4	3·8	2·4	67	7·0	347	6·8
Timor-Leste (2010)	7275	31·4	7·0	3720	51	2·1	1·4	4·1	2·5	38	8·7	130	5·7
Togo (2014)	3136	30·3	6·8	899	30	1·9	1·4	3·5	2·2	40	2·6	21	2·1
Uganda (2011)	2022	28·9	6·8	665	33	1·9	1·4	4·2	2·7	41	6·8	50	5·0
Yemen (2013)	13713	29·2	6·6	6090	45	2·0	1·4	3·9	2·7	5	1·1	16	1·9
Zambia (2014)	11 138	29·1	6·9	5368	49	2·0	1·4	3·8	2·4	139	7·5	360	7·8
Zimbabwe (2011)	4237	27·7	6·3	3587	85	1·7	1·4	2·6	1·7	39	6·8	69	6·2
Total	268 763	29·1	6·7	123 955	47	1·9	1·4	3·5	2·4	3837	6·1	4938	5·9

DRC, Democratic Republic of Congo; DR, Dominican Republic.
*Total and country-specific sample sizes are unweighted. The numbers of observations and percentages, and means and SD in the case of child's age, were estimated using the country-specific sample weight.
†Overweight (BMI *Z*-score > 2) was defined based on the 2006 WHO Child Growth Standards[33].
‡Type of employment was based on four indicators: (i) employment during the last 12 months (yes, no); (ii) aggregate occupation category (skilled, unskilled); (iii) type of earnings (cash only, cash and in-kind, in-kind only, unpaid); and (iv) seasonality of employment (all year, seasonally, occasionally).
§Maternal education level was dichotomized as less than secondary level of education and at least secondary level of education based on the high percentage (90 %) of women with at least secondary level of education completed.
‖Employment type was based on employment status, occupation category and earnings only because seasonality of employment was not queried in this survey.
¶Employment type was based on employment status, type of earnings and seasonality only because occupation type was not queried in this survey.

Informal employment was associated with higher odds of overweight in five countries (Cameroon, Chad, Colombia, Egypt, Haiti) and lower odds in another five countries (Peru, Rwanda, Sierra Leonne, Timor-Leste, Yemen; Figs. 2 and 3). When pooling estimates across all forty-five LMIC, neither formal employment (POR = 0·99; 95 % CI 0·89, 1·1) nor informal employment (POR = 0·99; 95 % CI 0·89, 1·1), compared with non-employment, was associated with child overweight (Table 2). Like estimates pooled across all LMIC, in countries where the association did not vary

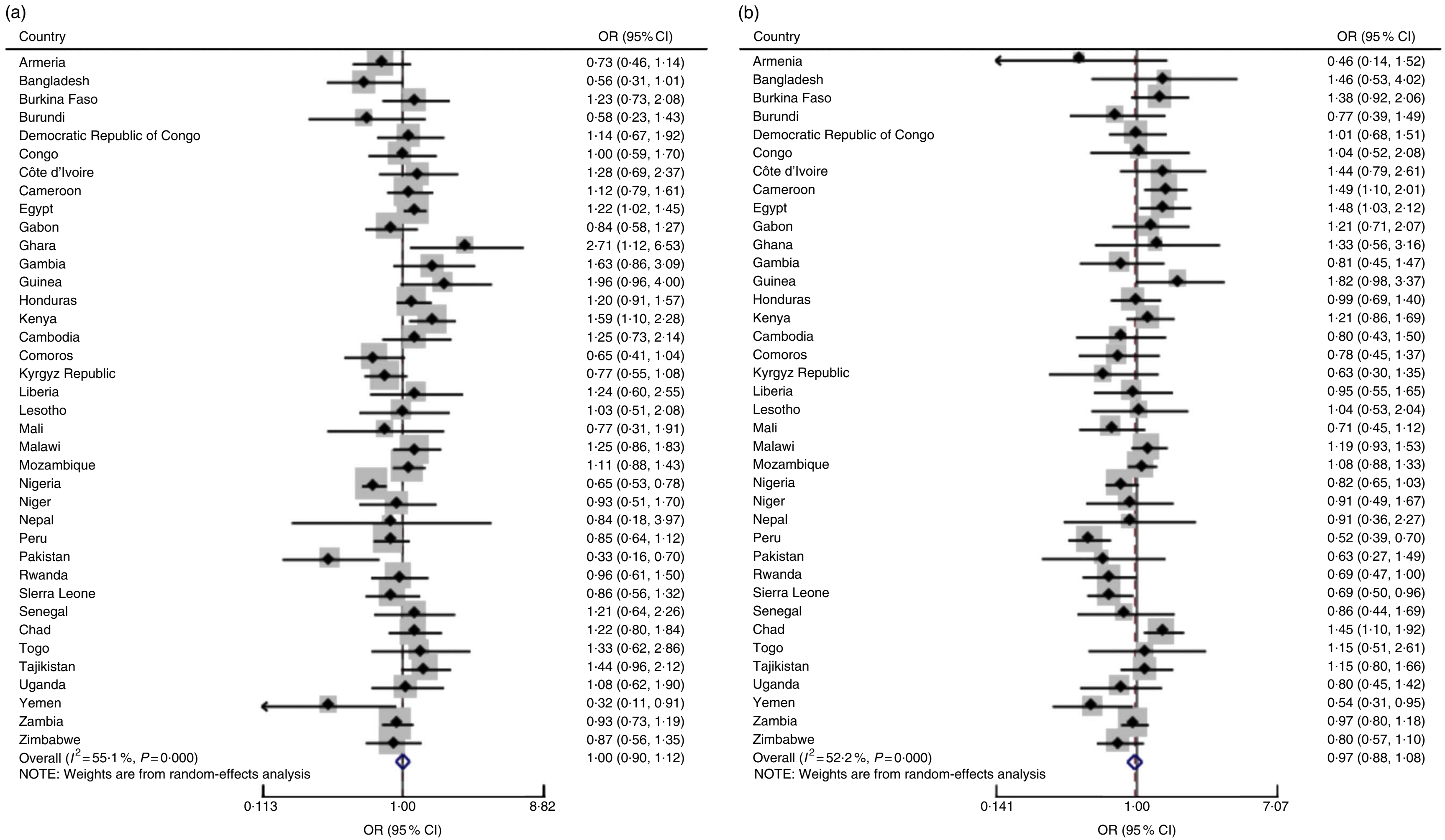

Fig. 2 Forest plots showing the relationship between maternal employment (a, formal employment; b, informal employment) and childhood overweight in thirty-eight low- and middle-income countries where the association did not vary by maternal education. The study-specific OR and 95 % CI are represented by the black diamond and horizontal line, respectively; the area of the grey square is proportional to the specific-study weight to the overall meta-analysis. The centre of the open diamond represents the pooled OR and its width represents the pooled 95 % CI. Country-specific OR ratios are estimated using logistic regression. Pooled OR are generated using meta-analysis and pool estimates across countries. Childhood overweight is defined as BMI Z-score > 2 based on the 2006 WHO Child Growth Standards[33]. Models were adjusted for maternal age (years), marital status (married, not married), number of household members, child's age (months), child's sex, substitute childcare provider (yes, no) and maternal education (less than primary education, at least primary education completed)

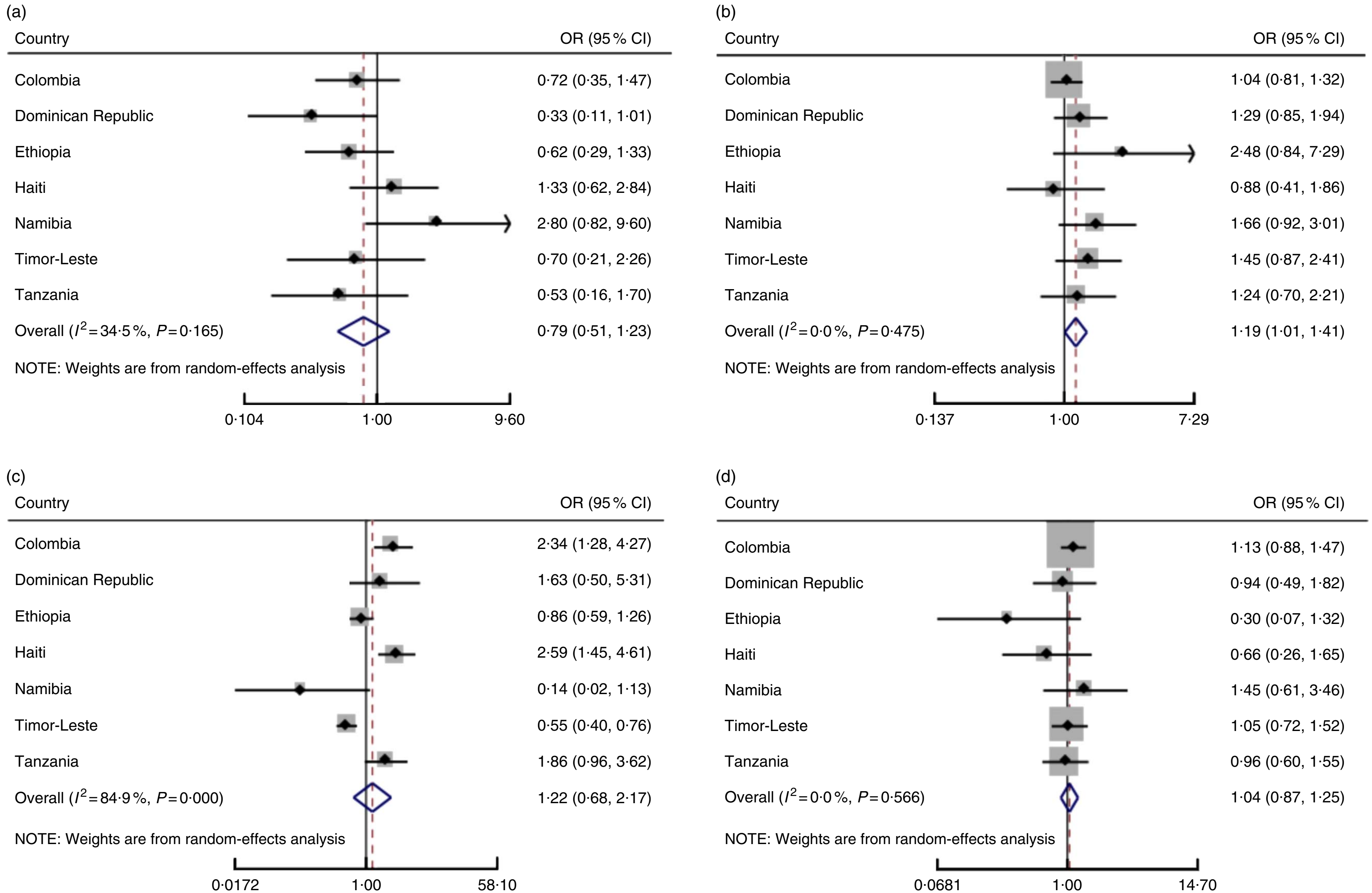

Fig. 3 Forest plots showing the relationship between maternal employment and childhood overweight in seven low- and middle-income countries where the association varied by maternal education (a, formal employment, low education; b, formal employment, high education; c, informal employment, low education; d, informal employment, high education). The study-specific OR and 95 % CI are represented by the black diamond and horizontal line, respectively; the area of the grey square is proportional to the specific-study weight to the overall meta-analysis. The centre of the open diamond and the vertical dashed line represent the pooled OR; the width of the open diamond represent represents the pooled 95 % CI. Country-specific OR are estimated using logistic regression. Pooled OR ratios are generated using meta-analysis and pool estimates across countries. Childhood overweight is defined as BMI Z-score > 2 based on the 2006 WHO Child Growth Standards[33]. Models were adjusted for maternal age (years), marital status (married, not married), number of household members, child's age (months), child's sex and substitute childcare provider (yes, no). Models include an employment × education interaction term (less primary education, at least primary education completed)

Table 2 Pooled OR for the relationship between formal and informal maternal employment and childhood overweight in selected low- and middle-income countries*

	N 268 763†	
	Pooled OR	95 % CI
Formal employment‡,§		
All low- and middle-income countries	0·99	0·89, 1·1
Countries where the association did not vary by education	1·0	0·90, 1·1
Countries where the association varied by education: low education‖	0·79	0·51, 1·2
Countries where the association varied by education: high education‖	1·2	1·0, 1·4
Informal employment‡,§		
All low- and middle-income countries	0·99	0·89, 1·1
Countries where the association did not vary by education	0·97	0·88, 1·1
Countries where the association varied by education: low education‖	1·2	0·68, 2·2
Countries where the association varied by education: high education‖	1·0	0·87, 1·3

*Pooled OR are generated using meta-analysis and pool estimates across country subgroups. Childhood overweight is defined as BMI *Z*-score > 2 based on the 2006 WHO Child Growth Standards[33]. Models are adjusted for maternal age (years), marital status (married, not married), number of household members, child's age (months), child's sex and proxy substitute childcare provider (yes, no). Models which did not retain the employment × education interaction term are also adjusted for maternal education (less than primary education, at least primary education).
†Total sample size is unweighted.
‡The following strata experienced small cell sizes, resulting in observations being omitted from the model: Armenia (childcare proxy *n* 1); Bangladesh (marital status *n* 79); Burundi (childcare proxy *n* 8); Ghana (childcare proxy *n* 19); Mali (childcare proxy *n* 14); Nepal (childcare proxy *n* 18, marital status *n* 4); Pakistan (childcare proxy *n* 26); Tajikistan (childcare proxy *n* 12); Uganda (childcare proxy *n* 24).
§Type of employment was based on four indicators: (i) employment during the last 12 months (yes, no); (ii) aggregate occupation category (skilled, unskilled); (iii) type of earnings (cash only, cash and in-kind, in-kind only, unpaid); and (iv) seasonality of employment (all year, seasonally, occasionally).
‖The employment × education interaction term was retained in the following countries: Colombia, Dominican Republic, Ethiopia, Haiti, Namibia, Tanzania and Timor-Leste. The relative difference in the employment–overweight association, comparing mothers with high and those with low education, is: for formal employment, POR = 1·7 (95 % CI 0·97, 2·9); for informal employment, POR = 0·71 (95 % CI 0·33, 1·5).

by education, neither formal nor informal employment was associated with childhood overweight (formal: POR = 1·0; 95 % CI 0·9, 1·1; informal: POR = 0·97; 95 % CI 0·88, 1·1).

Heterogeneity by maternal level of education

The association between employment and child overweight varied by maternal education in seven LMIC (Table 2 and Fig. 3). Children of formally employed women with high education had higher odds of overweight compared with children of non-employed women with high education (POR = 1·2; 95 % CI 1·0, 1·4). Additionally, maternal education modified the magnitude of the relationship between formal employment and childhood overweight. The combination of high education and formal employment (*v.* high education and non-employment) was associated with larger odds of childhood overweight, compared with the analogous combination of low education and formal employment (*v.* low education and non-employment; POR for difference in the associations = 1·7; 95 % CI 0·97, 2·9; *P* = 0·063).

Informal employment was not associated with overweight among children of women with low or high education (low education: POR = 1·2; 95 % CI 0·68, 2·2; high education: POR = 1·0; 95 % CI 0·87, 1·3). The magnitude of the association between informal employment and overweight was not different among children of women with high *v.* low education.

The meta-regression results indicated that neither the formal employment–overweight nor the informal employment–overweight association differed by log(GDP) or urbanization (Table 3 and online supplementary material, Supplemental Figs 1 and 2).

Sensitivity analyses

Results were substantively similar in magnitude and direction when including current breast-feeding status as a confounder (online supplementary material, Supplemental Table 3), when excluding wasted children (Supplemental Table 4), when controlling for maternal BMI (Supplemental Table 5) and when controlling for birth order (Supplemental Table 6). However, when controlling for maternal BMI, the association between formal employment (compared with non-employment) and overweight among children of women with high education was no longer significant (POR = 1·1; 95 % CI 0·97, 1·4).

When stratifying results by child's age, results were unchanged in countries where the employment–overweight association did not vary by education. In countries where the association varied by education, children aged >24 months of formally employed women with high education had higher odds of overweight (POR = 1·3; 95 % CI 1·0, 1·7), compared with children aged >24 months of non-employed women with high education (online supplementary material, Supplemental Table 7). The point estimate for the analogous association among children ≤24 months of age was somewhat lower, but in the same direction (POR = 1·1; 95 % CI 0·80, 1·6).

Results were unchanged when modelling at-risk-of-overweight as the outcome (Table 4). Notably, children of formally employed mothers, compared with non-employed, had lower odds of underweight (POR = 0·83; 95 % CI 0·76, 0·90; Table 4). Correspondingly, children of formally employed mothers had higher odds of normal weight when defined based on WAZ (POR = 1·2; 95 % CI 1·1, 1·3; Table 4). The point estimate was in the same direction when normal weight was defined based on BMI *Z*-score (POR = 1·1; 95 % CI 0·98, 1·2). Informal employment was not associated with underweight, although the point estimates went in the same direction as those for formal employment, in countries where the employment–overweight association varied by education (low education: POR = 0·91; 95 % CI 0·70, 1·2; high education:

Table 3 Meta-regression results for the association between formal and informal maternal employment and childhood overweight by log (GDP) and percentage urban in selected low- and middle-income countries*

	Log(GDP)†		Percentage urban†,‡	
	β	95 % CI	β	95 % CI
Formal employment§				
All low- and middle-income countries	−0·083	−0·21, 0·046	−0·0025	−0·0086, 0·0037
Countries where the association did not vary by education	−0·084	−0·22, 0·050	−0·0023	−0·0088, 0·0043
Countries where the association varied by education: low education‖	−0·014	−0·70, 0·67	−0·0017	−0·032, 0·028
Countries where the association varied by education: high education‖	−0·081	−0·35, 0·19	−0·0064	−0·017, 0·0045
Informal employment§				
All low- and middle-income countries	0·0045	−0·14, 0·15	0·0021	−0·0047, 0·0089
Countries where the association did not vary by education	−0·042	−0·18, 0·096	−0·0029	−0·0094, 0·0036
Countries where the association varied by education: low education‖	0·083	−0·88, 1·0	0·017	−0·015, 0·050
Countries where the association varied by education: high education‖	0·11	−0·15, 0·37	0·0028	−0·0076, 0·013

Log(GDP), gross domestic product per capita, adjusted for purchasing power.
*β coefficients were generated using meta-regression and pool estimates across country subgroups. Models were adjusted for maternal age (years), marital status (married, not married), number of household members, child's age (months), child's sex and substitute childcare provider (yes, no). Models which did not retain the employment × education interaction term were also adjusted for maternal education (less than primary level of education, at least primary level of education).
†Log(GDP) and percentage urban were obtained from the World Development Indicators database[43] and correspond to the survey year used.
‡Percentage urban was defined as the number of people living in urban areas divided by the total population.
§Type of employment was based on four indicators: (i) employment during the last 12 months (yes, no); (ii) aggregate occupation category (skilled, unskilled); (iii) type of earnings (cash only, cash and in-kind, in-kind only, unpaid), and (iv) seasonality of employment (all year, seasonally/occasionally).
‖The employment × education interaction term was retained in the following countries: Colombia, Dominican Republic, Ethiopia, Haiti, Namibia, Tanzania and Timor-Leste.

Table 4 Pooled OR for the relationship between maternal employment and childhood underweight, normal weight and at-risk-of-overweight in selected low- and middle-income countries*

	N 268 763†							
	Underweight: WAZ < −2		Normal weight: WAZ ≥ −2 to <2		Normal weight: BMI *Z*-score ≥ −2 to <2		At-risk-of-overweight: BMI *Z*-score > 1	
	Pooled OR	95 % CI	Pooled OR	95 % CI	Pooled OR	95 % CI	Pooled OR	95 % CI
Formal employment‡								
All low- and middle-income countries	0·83	0·76, 0·90	1·2	1·1, 1·3	1·1	0·98, 1·2	1·0	0·96, 1·1
Countries where the association did not vary by education	0·83	0·75, 0·91	1·2	1·1, 1·3	1·0	0·98, 1·1	1·0	0·96, 1·1
Countries where the association varied by education: low education§	0·83	0·66, 0·99	1·2	0·97, 1·4	1·2	0·85, 1·7	0·99	0·83, 1·2
Countries where the association varied by education: high education§	0·78	0·66, 0·91	1·1	0·88, 1·4	0·92	0·79, 1·1	1·2	1·0, 1·3
Informal employment‡								
All low- and middle-income countries	1·0	0·97, 1·1	1·0	0·92, 1·1	1·1	1·0, 1·1	1·0	0·94, 1·1
Countries where the association did not vary by education	1·1	0·98, 1·2	1·0	0·89, 1·2	1·1	1·1, 1·2	1·0	0·93, 1·1
Countries where the association varied by education: low education§	0·91	0·70, 1·2	0·96	0·79, 1·2	0·93	0·77, 1·1	1·1	0·81, 1·4
Countries where the association varied by education: high education§	0·91	0·60, 1·4	0·86	0·73, 1·0	0·97	0·73, 1·3	1·0	0·90, 1·2

WAZ, weight-for-age *Z*-score.
*Pooled OR were generated using meta-analysis and pool estimates across country subgroups. Weight status was defined based on the 2006 WHO Child Growth Standards[33]. Models were adjusted for maternal age (years), marital status (married, not married), number of household members, child's age (months), child's sex and proxy substitute childcare provider (yes, no). Models which did not retain the employment × education interaction term were also adjusted for maternal education (less than primary education, at least primary education).
†Total sample size is unweighted.
‡Type of employment was based on four indicators: (i) employment during the last 12 months (yes, no); (ii) aggregate occupation category (skilled, unskilled); (iii) type of earnings (cash only, cash and in-kind, in-kind only, unpaid); and (iv) seasonality of employment (all year, seasonally, occasionally).
§The employment × education interaction term was retained in the following countries: Colombia, Dominican Republic, Ethiopia, Haiti, Namibia, Tanzania and Timor-Leste.

POR = 0·91; 95 % CI 0·60, 1·4). Informal employment was associated with normal weight when defined based on BMI *Z*-score (POR = 1·1; 95 % CI 1·0, 1·2). The point estimate went in the same direction when normal weight was defined based on WAZ (POR = 1·0; 95 % CI 0·92, 1·1). Finally, children of formally employed mothers, compared with children of non-employed mothers, had a higher BMI *Z*-score (pooled $\beta = 0{\cdot}042$; 95 % CI 0·002, 0·082; Table 5). The point estimate for the relationship between informal employment and BMI *Z*-score followed a similar positive trend (pooled $\beta = 0{\cdot}033$; 95 % CI −0·010, 0·076).

Table 5 Adjusted linear regression for the relationship between formal and informal maternal employment and child BMI Z-score in selected low- and middle-income countries*

			Mean BMI Z-score		Formal employment†		Informal employment†	
Country	Year	N	β	SD‡	β	95 % CI‡	β	95 % CI‡
Armenia§	2010	1329	0·7	1·6	−0·21	−0·54, 0·12	−0·51	−1·1, 0·062
Bangladesh	2014	6518	−0·7	1·2	−0·095	−0·18, −0·0067	−0·14	−0·33, 0·048
Burkina Faso	2010	6455	−0·5	1·5	0·091	−0·042, 0·22	0·024	−0·084, 0·13
Burundi	2010	3393	−0·0	1·2	0·043	−0·19, 0·28	0·034	−0·17, 0·23
Cambodia	2014	4314	−0·5	1·2	0·13	0·023, 0·24	0·043	−0·078, 0·16
Cameroon	2011	4944	0·3	1·4	0·14	0·0019, 0·27	0·14	0·025, 0·26
Chad	2014	9873	−0·4	1·4	0·29	0·17, 0·40	0·28	0·20, 0·37
Colombia‖,¶	2010	15 369	0·4	1·0	0·020	−0·095, 0·13	0·17	0·048, 0·29
Comoros	2012	2226	0·0	1·8	−0·23	−0·52, 0·063	−0·14	−0·43, 0·16
Congo	2011	4289	−0·1	1·2	−0·011	−0·15, 0·13	−0·12	−0·28, 0·042
Côte d'Ivoire	2012	3110	−0·1	1·3	0·028	−0·15, 0·21	0·17	0·022, 0·31
DRC	2014	7988	−0·0	1·4	0·11	−0·070, 0·28	−0·039	−0·18, 0·11
DR	2013	3050	0·3	1·2	−0·11	−0·34, 0·12	0·12	−0·22, 0·46
Egypt	2014	14 267	0·4	1·8	0·16	0·028, 0·30	0·49	0·22, 0·76
Ethiopia¶	2011	9527	−0·3	1·3	0·11	−0·029, 0·25	0·0031	−0·088, 0·094
Gabon	2012	3229	0·3	1·3	−0·13	−0·28, 0·0092	0·077	−0·086, 0·24
Gambia	2013	3097	−0·5	1·4	0·15	−0·067, 0·37	0·042	−0·11, 0·19
Ghana	2014	2623	−0·2	1·1	0·17	0·0016, 0·34	0·16	−0·0013, 0·32
Guinea	2012	2973	−0·2	1·4	0·00099	−0·23, 0·24	0·084	−0·098, 0·27
Haiti¶	2012	3932	−0·1	1·2	0·072	−0·085, 0·23	0·11	−0·041, 0·25
Honduras	2012	9531	0·4	1·0	0·13	0·068, 0·20	0·12	0·044, 0·19
Kenya	2014	8806	0·1	1·2	0·26	0·16, 0·36	0·16	0·074, 0·25
Kyrgyz Republlic§	2012	3989	0·5	1·3	−0·076	−0·22, 0·065	−0·18	−0·42, 0·057
Lesotho	2014	1239	0·4	1·3	0·0039	−0·24, 0·25	−0·16	−0·39, 0·068
Liberia	2013	3110	−0·1	1·3	−0·074	−0·24, 0·094	−0·026	−0·16, 0·11
Malawi	2010	4518	0·5	1·4	0·011	−0·17, 0·20	0·045	−0·073, 0·16
Mali	2013	3680	−0·4	1·5	0·15	−0·024, 0·32	0·14	0·0035, 0·27
Mozambique	2011	9237	0·3	1·5	0·084	−0·067, 0·23	−0·047	−0·15, 0·057
Namibia¶	2013	1734	−0·1	1·4	0·055	−0·38, 0·49	0·31	−0·069, 0·69
Nepal	2011	2274	−0·5	1·2	0·15	−0·12, 0·42	−0·059	−0·21, 0·092
Niger	2012	4838	−0·7	1·5	0·22	0·066, 0·38	0·10	−0·049, 0·24
Nigeria	2013	24 755	−0·5	1·7	−0·089	−0·17, −0·0074	0·10	0·0015, 0·20
Pakistan	2013	3251	−0·3	1·5	−0·084	−0·25, 0·085	−0·14	−0·37, 0·086
Peru**	2012	9030	0·6	1·0	−0·039	−0·12, 0·038	−0·17	−0·25, −0·096
Rwanda	2014	3529	0·6	1·2	−0·28	−0·48, −0·083	−0·30	−0·48, −0·13
Senegal	2014	5937	−0·3	1·1	0·10	−0·0032, 0·21	0·10	−0·0075, 0·21
Sierra Leone	2013	4197	0·2	1·7	−0·15	−0·38, 0·089	−0·079	−0·26, 0·10
Tajikistan	2012	4553	−0·1	1·6	0·098	−0·078, 0·27	0·026	−0·13, 0·18
Tanzania¶	2010	6709	0·2	1·3	0·34	0·043, 0·64	0·40	0·21, 0·59
Timor-Leste¶	2010	7275	−0·5	1·7	−0·11	−0·52, 0·31	−0·30	−0·44, −0·17
Togo	2014	3136	−0·2	1·1	0·12	−0·022, 0·26	0·047	−0·098, 0·19
Uganda	2011	2046	0·1	1·3	0·23	0·037, 0·42	0·087	−0·091, 0·26
Yemen	2013	13 713	−0·7	1·4	−0·11	−0·27, 0·054	0·032	−0·084, 0·15
Zambia	2014	11 138	0·2	1·4	−0·12	−0·22, −0·025	−0·069	−0·14, 0·0065
Zimbabwe	2011	4237	0·3	1·2	0·028	−0·11, 0·17	0·026	−0·075, 0·13
Total/pooled β		268 968	−0·065	1·4	0·042	0·0020, 0·082	0·033	−0·010, 0·076

DRC, Democratic Republic of Congo, DR, Dominican Republic.
*Country-specific β coefficients are estimated using linear regression. All models were adjusted for maternal age (years), marital status (married, not married), number of household members, child's age (months), child's sex and proxy substitute childcare provider (yes, no). Models which did not retain the employment × education interaction term were also adjusted for maternal education (less than primary level of education, at least primary level of education). Pooled coefficients are generated using meta-analysis and pool estimates across all low- and middle-income countries.
†Type of employment was based on four indicators: (i) employment during the last 12 months (yes, no); (ii) aggregate occupation category (skilled, unskilled, unemployed); (iii) type of earnings (cash only, cash and in-kind, in-kind only, unpaid); and (iv) seasonality of employment (all year, seasonally/occasionally).
‡Small cell sizes resulted in missingness in some overweight models. These observations were retained in the above models where BMI Z-score was the outcome: Armenia (childcare proxy n 1); Bangladesh (marital status n 79); Burundi (childcare proxy n 8); Ghana (childcare proxy n 19); Mali (childcare proxy n 14); Nepal (childcare proxy n 18, marital status n 4); Pakistan (childcare proxy n 26); Tajikistan (childcare proxy n 12); Uganda (childcare proxy n 24).
§Maternal education level was dichotomized as less than secondary level of education and at least secondary level of education.
‖Employment type based on employment status, occupation and earnings only because seasonality of employment was not queried in this survey.
¶Includes employment × education interaction term.
**Employment type based on employment status, type of earnings and seasonality only because occupation type was not queried in this survey.

Discussion

The present study leveraged data from forty-five countries to investigate whether there was any association between maternal employment and childhood overweight in LMIC. As environments change, it is important to better understand the benefits, as well as any unintended consequences, of maternal employment on children's weight

https://doi.org/10.1017/S1368980017001720 Published online by Cambridge University Press

status given the potential need for additional policies and programmes to support women in the workplace and prevent childhood overweight. In most countries, we did not observe an association between formal or informal employment and childhood overweight. However, children of employed mothers had a modestly higher BMI *Z*-score, higher odds of normal weight and lower odds of underweight. The employment–overweight association varied by maternal education level in seven countries. In these countries, children of formally employed women with high education had higher odds of overweight compared with children of non-employed women with high education.

Contrary to results from South Africa and high-income countries, we found that neither formal nor informal maternal employment was associated with risk for childhood overweight in most countries[1–4,18]. The low prevalence of overweight in some strata (e.g. children of informally employed women) is one plausible reason that we found a null association in most LMIC. However, several other factors may help explain these null findings. In multigenerational households where grandmothers are in part responsible for meal preparation, eating patterns at home may not change even if the mother is employed. Also, young children may have limited access to energy-dense foods in these contexts. Alternatively, children still have a negative BMI *Z*-score on average (BMI *Z*-score: –0·065); in contexts where the BMI *Z*-score is still negative on average, earned income may be going towards goods that are currently associated with healthy weight gain in LMIC. Correspondingly, energy needs of children aged 0–5 years are relatively high, due to growth[47]. Subsequently, increases in household food expenditures may result in only modest shifts in energy balance.

Differences in the work and home environments in most LMIC, compared with higher-income contexts like South Africa or the USA, also offer possible explanations for our findings. Informal employment may afford flexibility in hours and allow children in LMIC to accompany their mother to work. This is in stark contrast to the formal labour market in the USA, which demands longer working hours and offers childcare arrangements that are less flexible. Evidence also suggests that increased screen time among children is a key mechanism of the employment–childhood overweight association in the USA[4]. Screen time promotes sedentary behaviour, but also increases children's exposure to food-related advertisements; however, children in LMIC are subject to less screen time than children in the USA[4,48].

At the same time, we found that formal employment and (to a lesser degree) informal employment, compared with non-employment, are associated with beneficial effects on children's weight status as maternal employment was associated with a higher BMI *Z*-score, paired with higher odds of normal weight and lower odds of underweight. In this sample, a higher BMI *Z*-score seems to be a positive change to average weight status. However, we expect that over time there will be increases in women's labour force participation in LMIC and in the future, there will be a rightward shift in the BMI distribution among children, like we have seen in adults in these contexts[49]. In a well-nourished population, a positive association between maternal employment and BMI *Z*-score could have unintended consequences for childhood obesity risk. Having followed a similar pattern in the USA, it is estimated that maternal employment contributed to approximately 10 % of the overall increase in childhood overweight[5].

Among children of women with high education, we found that formal employment, compared with non-employment, was associated with higher odds of overweight (POR = 1·2; 95 % CI 1·0, 1·4). Formally employed mothers may have additional time constraints compared with their non-employed counterparts, which could lead to higher odds of childhood overweight. Descriptive data from the Philippines suggest that employed mothers, compared with non-employed mothers, spend 3.2 h less per day on childcare and evidence suggests that unsupervised children consume more energy, as compared with supervised children, which would be expected to ultimately affect child weight status[11,50]. Formally employed, more highly educated women are among the wealthiest women in many LMIC (Supplemental Table 2). In countries at an earlier phase of the nutrition transition (e.g. Ethiopia, Tanzania), we might expect that wealthier women are able to use their earned income from employment to increase their purchase of energy-dense foods[10,11]. Comparatively, in countries further along in the nutrition transition (i.e. upper middle-income), energy-dense foods may be affordable and accessible to almost everyone, including lower-income women. The transformation of the food and built environments as LMIC undergo their nutrition transition, such as the spread of supermarkets and availability of ultra-processed foods, may provide an enabling environment for the hypothesized changes among children of formally employed women with high education[51–53].

We additionally found that the formal employment effect differed by maternal education level (high *v*. low education: POR = 1·7; 95 % CI 0·97, 2·9; $P = 0·063$). Although contrary to our hypothesis that higher maternal education (*v*. lower education) within the formal or informal sector would be associated with lower odds of child overweight, our findings are similar to US-based studies which find that the risk of child overweight associated with employment is greater for more highly educated women than it is for less-educated women[1,4]. More highly educated formally employed women are more likely to be shifting into full-time employment, as those types of jobs emerge in the formal labour sector in LMIC[41]. Therefore, highly educated, formally employed women may be working longer hours, resulting in increased time constraints. We speculate that these women may spend less time preparing meals or caring for their child, which could lead to increased childhood overweight through increased reliance on ready-prepared foods which tend to be more energy-dense[54]. It also may be difficult to find caregivers who have knowledge and skills equal to those of more highly educated mothers[17]. Women with relatively low education in the formal sector may be employed in positions that are lower paying and entail longer hours (e.g. factory work or shift work), compared with women with a high education (e.g. teacher). For these women with low education, more nominal increases in income may not afford substantive increases in household food expenditures and, in particular, may not allow mothers to increase their purchase of energy-dense foods[29].

The limitations of our study should be noted. Our findings may not be generalizable to older aged children and adolescents and children who are not living in the same residence as their mother. Similarly, countries retained for these analyses may not be representative of other LMIC which no longer participate in DHS, such as upper middle-income countries that now administer their own survey (e.g. Mexico). This sample includes mostly low-income countries (*n* 24), which may limit our ability to observe variation in the association by country-level factors. We cannot infer causality and unmeasured or residual confounding is possible with the use of cross-sectional data. Countries are likely at different stages of their nutrition transitions, but we have aimed to keep samples comparable by selecting countries with a recent DHS (2010–2016) and we allow for different relationships in each country by starting with disaggregated estimates. Finally, non-employed women who choose to not seek employment are likely different from non-employed women who are actively seeking employment, and those differences could affect child overweight risk. However, we cannot distinguish between these two types of women in the DHS.

Despite some limitations, a key strength of the present study is utilizing data from forty-five countries to gain a better understanding of the maternal employment–childhood overweight relationship as countries undergo their nutrition transition. Moreover, these results have several implications for public health. These findings suggest that countries should continue to monitor child overweight prevalence in relation to maternal employment status. There may also be an opportunity to prevent future increases in childhood overweight like those observed in the USA. Countries could consider implementing policies which both support women's employment and may prevent childhood overweight; as more women are expected to enter the formal labour force in LMIC, such policies might include subsidized childcare, with provisions for providing healthy food, or include programmes modelled after Head Start which has had beneficial effects on children's BMI in the USA[55].

Conclusions

Utilizing nationally representative data, we did not observe an association between formal or informal employment and overweight in most LMIC. Yet, overall, our results indicate that employment is associated with a modestly higher BMI *Z*-score, higher odds of normal weight and lower odds of underweight, suggesting that maternal employment is currently associated with beneficial effects on children's weight status in LMIC. As countries undergo their nutrition transitions and BMI *Z*-scores increase among children on average, it will be important to continue to monitor trends of childhood overweight in relation to maternal employment to both support women in the workforce and mitigate future risk of overweight among children in LMIC.

Acknowledgements

Financial support: This work was supported by the National Institutes of Health, Clinical Research and Endocrinology Training Grant in Epidemiology in Diabetes (grant number T32DK062707). The National Institutes of Health had no role in the design, analysis or writing of this article. *Conflict of interest:* The authors do not have any conflicts of interest to disclose. *Authorship:* The authors contributed as follows: V.M.O. and J.C.J-.S. conceptualized the research question and analysis plan; V.M.O. analysed the data; V.M.O. drafted the manuscript with critical input from N.T.M., S.N.B., K.M.P., P.J.S. and J.C.J-.S.; all authors reviewed and approved the final manuscript. *Ethics of human subject participation:* The Johns Hopkins Institutional Review Board deemed that this analysis of de-identified secondary data was not human subjects research.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980017001720

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