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Association between Women's Empowerment and Childhood Undernutrition in Cambodia: Evidence from the 2014 Demographic Health Survey

F. Trauner[1], J. Stewart Williams[2]

[1] Department of Health Economics and Health System Analysis, Austrian National Public Health Institute (Gesundheit Österreich GmbH),1010, Vienna, Austria, [2] Department of Epidemiology and Global Health, Umeå University, SE-90187, Umeå, Sweden

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ABSTRACT

Introduction

In Cambodia childhood undernutrition - stunting, wasting and underweight - is widespread. In 2020 stunting was the most common form, affecting almost every third child under five. International studies have found positive associations between women's autonomy in household decision-making and children's nutritional status. Yet, little is known about these issues in Cambodia. This study aims to identify the extent to which mothers' empowerment (resources, agency, and achievement) is a predictor of undernutrition (stunting, wasting and underweight) in children aged 0-59 months in Cambodia.

Methods

Cross-sectional data from 3,453 mother-and child dyads in the 2014 Cambodian Demographic and Health Survey were analysed. Logistic regression methods were used to separately show the predicted values of each dependent variable (stunting, wasting and underweight) given a one unit change in each independent variable (resources, agency, and achievement). Multivariable logistic regressions adjusted for the effects of sociodemographic confounders.

Results

Children of women with higher agency were significantly less likely to be underweight in the adjusted model (AOR: 0.76; 95% CI 0.63-0.93). Women with education above the secondary level were significantly less likely to have children who were stunted (OR: 0.16; 95% CI 0.08-0.33) or underweight (OR: 0.17; 95% CI 0.07-0.44). There was notable geographic variation across Cambodia. Preah Vihear and Stung Treng were the most disadvantaged provinces for both empowerment and child undernutrition.

Conclusions

Policies that increase women's decision-making power and labour-force participation can benefit their children's nutritional status. Women's education is an important determinant of child nutrition. More research, both qualitative and quantitative, is needed to identify the specific aspects of women's empowerment that are relevant for childhood undernutrition in Cambodia.

* Corresponding author: Steward Williams. J Jennifer.Stewart.Williams@umu.se

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Introduction

The World Health Organization (WHO) estimates that globally in 2021, one hundred and forty-nine million children under-five are stunted (low height for age), forty-five million are wasted (low weight for height) and eight-five million are underweight [1-3]. Child undernutrition is an underlying cause of sixty percent of deaths in children under five in low- and middle-income countries (LMICs) [4, 5]. Chronic malnutrition curtails cognitive and neuro-behavioural development and deprives adults of opportunities to reach their productive capacity [3]. This is a critical issue for public health as well as for social and economic development [6-8]. The commitment to end all forms of malnutrition and achieve internationally agreed targets on stunting and wasting in under-five aged children by 2030, is enshrined in the United Nations (UN) Sustainable Development Goal 2 (SDG 2) [9]. International agencies now warn that childhood stunting and wasting in LMICs is likely to worsen as a consequence of the COVID-19 pandemic [8, 10].

The highest prevalence of childhood stunting, wasting and underweight is in the South Asian Region [4]. Child wasting (14.8%) and severe wasting (4.5%) is double the prevalence in the next highest region, Sub-Saharan Africa [6, 11]. In South Asia almost two out of every five children are stunted and almost 30% are underweight [3, 10, 12-14]. According to WHO, in 2021, fifty-one million children aged under five in South Asia were stunted, twenty-five million were wasted and forty-two million were underweight [2].

Child undernutrition is not simply caused by lack of adequate, nutritious food but the result of intersecting conditions encompassing family health, sanitation and caring practices and traversing households' and communities' social and economic circumstances in health and other sectors [8, 15, 16]. The UN Children's Fund (UNICEF) Framework [4, 17-19] captures multi-factorial issues which underlie children's nutrition. Understanding these patterns within a country's social, economic, and political context is crucial for improving child nutrition.

The bulk of research which has looked at associations between women's empowerment and child nutrition has been undertaken in and across countries in South Asia and the Sub-Saharan African continent [4, 20-22]. Although many findings are not statistically significant [21] the patterns confirm a trend whereby women's demonstrated capacity towards autonomy and self-determination is associated with improvements in maternal and child nutrition [19, 22]. Analysis of Demographic Health Surveys (DHSs) in thirty sub Saharan African countries (2011-2017) demonstrated positive association between women's autonomy in household decision-making and children's nutritional status [23]. Studies in Pakistan found that mothers' education and employment was protective of child malnutrition [24, 25]. Studies in India have shown that mothers' decision-making autonomy was protective of wasting, underweight and low birthweight [26, 27]. In Bolivia, children of mothers with higher agency were less likely to suffer diarrhoea [28] and research in Kenya showed that intimate partner violence increased the risk of child stunting [29].

Cambodia is a lower- middle-income economy in South-East Asia. Despite the country's recent achievements in lowering poverty, increasing access to education and improving sanitation [30], over thirty percent of children under five are stunted, ten percent are wasted and over twenty percent are underweight. Stunting is more common in rural (34%) than urban (24%) areas, and less common among children of more highly educated mothers [31]. Children from households with lower wealth are more likely to be malnourished compared with children from wealthier households [31]. Levels of stunting vary widely across provinces, ranging from, for example, between eighteen percent in Phnom Penh and forty-four percent in Preah Vihear and Stung Treng [31].

Many young women of child-bearing age in Cambodia are constrained by parental illiteracy and limited understanding of the economic and social importance of education [32, 33]. Poverty and social norms restrict their ability to exercise agency and achieve socially and economically [34]. Most Cambodian women report lower earnings than their partners and less than thirty-two percent earn at least as much as their partners. Less than half of the Cambodian mothers decide alone on their own health care, do not tolerate any wife beating, or use modern contraception methods [32].

Studies on women's empowerment in Cambodia have shown that women's increasing power in household-decision-making, higher educational attainment and greater labour force participation have led to increased use of contraceptives [35] and greater use of antenatal care services in recent years [36, 37]. However, to our knowledge this is the first national Cambodian study to investigate the extent to which

mothers' empowerment predicts stunting, wasting and underweight in children aged under five.

Women's empowerment is a complex multifaceted phenomenon [25]. This paper draws on the esteemed work of Naila Kabeer [38, 39] which conceptualises women's empowerment as three independent yet inter-related dimensions: resources, agency and achievements. Resources, also called pre-conditions, are human, social, and material resources. Agency reflects the power to decide and the processes leading to achievements. Achievements are the outcome of empowerment [38, 40, 41]. Kabeer's measures of empowerment are used here 'indicate' the direction in which change is needed [39].

The aim of this study is to identify associations between women's empowerment (resources, agency, and achievement) and undernutrition (stunting, wasting and underweight) in children aged 0-59 months in Cambodia. An adaptation of the original UNICEF conceptual framework [17, 19] provides the conceptual basis for the analyses.

Methods

1. Data Source

This paper reports a secondary analysis of data collected in the 2014 Cambodian Demographic and Health Survey (CDHS) [32] which randomly sampled 16,356 households, 99 percent of which returned completed questionnaires. Two-stage stratified sampling was conducted across separate urban and rural areas. Four types of questionnaires - the Household Questionnaire, the Woman's Questionnaire, the Man's Questionnaire, and the Micronutrient Questionnaire – were administered.

All women aged 15-49 years in the selected households were asked to respond to the Woman's Questionnaire which covered reproduction, marital partners, childhood immunization and domestic violence. The response rate was 98 percent. Children aged 0 to 59 months were measured for weight and height. This paper reports an analysis of data on women, their partners and children collected in the CDHS Woman's Questionnaire between June 2014 and December 2014. The CDHS survey was ethically reviewed and approved by the Inner City Fund (ICF) Independent Review Board.

2. Study sample

The study sample included only mothers currently living with a male partner who had at least one child aged under five measured with plausible values for age, height, and weight. This generated 3,488 mother-child dyads for the analysis. If women had more than one fully measured child under five, the oldest was selected. **Figure 1** illustrates the derivation of the analytical sample resulting in 3,453 dyads with complete data.

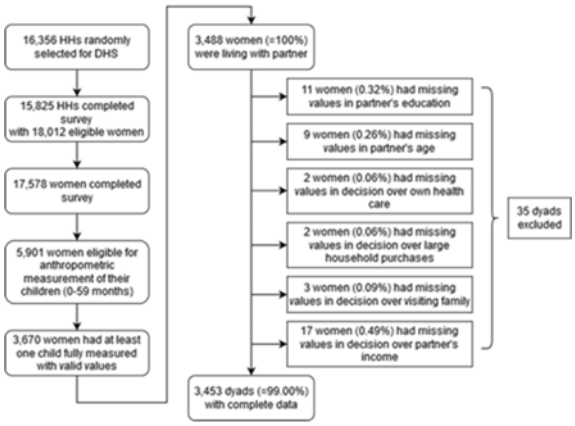

Figure 1: Flow chart diagram of the formation of the study sample

3. Dependent variables

The three binary variables, child stunting, wasting and underweight, were measured using the WHO Child Growth Standards [42], where z-scores measured deviation from the WHO child growth standard median for all three nutritional outcomes. Stunting is defined as the WHO height-for-age z-score (HAZ) <-2 SD, wasting as a weight-for-height z-score (WHZ) <-2 SD and underweight as a weight-for-age z-score (WAZ) <-2 SD.

4. Independent variables

Resources, agency and achievements are the three dimensions of women's empowerment based on Kabeer's conceptualisation [38, 39]. Data on women's years of education and income relative to that of their partners, access to media, and ownership of house and/or land were used to indicate resources. Agency was assessed using data about women's decision-making power about their, and their partners' income, health care, large household purchases, and visiting family. For the achievements indicator we captured information on the type of union (monogynous or polygynous), women's justification for the practice of wife beating, the regularity of their occupation and their use of contraceptives. Scores were summed across the items in each dimension and the aggregate scores were

coded as binary variables (denoting high versus low scores) using median cut-points.

5. *Covariates*

The choice of potential confounding variables was informed by the literature [17, 19]. Candidate variables were women's age (15-49 years, 15-28 years, 29-49 years), educational level (no education, primary, lower secondary, upper secondary, higher) household wealth quintiles, place of residence (urban and rural), number of living children (less than or equal to two children, three plus children), partner's educational level (no education, primary, lower secondary, upper secondary, higher), child's age (less than six months, six to twenty three months, twenty four to fifty nine months) and child's sex (male, female). Household wealth quintiles were calculated using self-reported information on dwelling and household characteristics, consumer goods and assets [32]. Each household asset was assigned a weight generated through principal component analysis. The scores were standardised and used to create cut-points to define 'wealth quintiles' as a measure of socioeconomic status.

6. *Statistical analysis*

The study sample (3,453 dyads) is described by women's and children's sociodemographic characteristics using weighted observations for categorical variables and means and standard deviations for continuous variables. Second, parallel bivariate tests of association (Pearsons' corrected weighted Chi Square) were conducted to identify associations between sociodemographic characteristics and 1) the exposure variable, 'women's empowerment' and 2) the outcome variable, 'childhood undernutrition'. Covariates significantly associated ($p<0.1$) with undernutrition were retained for inclusion as possible confounders in the multivariable models. Third, nine sets of multivariable logistic regression tested association between the women's empowerment dimensions (resources agency and achievements) and the childhood undernutrition measures (stunting, wasting and underweight) in the presence of potential confounders. Estimates are reported as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance is presented at the 5%, 1% and 0.1% levels. Multicollinearity was assessed by the Variance Inflation Factor (VIF) whereby VIF<5.0 indicated independence. Homer-Lemeshow goodness-of-fit (GOF) tested model calibration; $p<0.05$ indicated lack of fit. Geographic differences in undernutrition and women's empowerment are described in Appendix tables and figures. Only records with complete data were included; less than 1% of records included missing data. All analyses were weighted using survey sample weights provided by CDHS. The analyses were undertaken using statistical software Stata (Version 16.0, StataCorp, College Station, Texas, USA).

Results

1. *Study sample*

The study sample consists of 3,453 dyads of mothers and their oldest anthropometrically measured children aged under five. (**Table 1**). Women's mean age is 28.6 years, and the mean age of children is 31 months. Almost every third child is stunted, nearly one in ten children were wasted and more than one in four were underweight.

Table 1: Description of study dyads (N=3,453)

		Weighted Observations	Mean (SD)/%
Women's characteristics		3,519.0	
Age (years)	15-49 years	3,453	28.62 (6.04)
	15-28 years	1,875.1	53.28
	29-49 years	1,643.9	46.72
Educational level	No education	433.4	12.32
	Primary	1,936.8	55.04
	Lower secondary	799.2	22.71
	Upper secondary	259.7	7.38
	Higher	89.8	2.55
Wealth quintile	Poorest	826.6	23.49
	Poorer	698.9	19.86
	Middle	670.6	19.06
	Richer	641.1	18.22
	Richest	681.8	19.38
Place of residence	Urban	502.1	14.27
	Rural	3,016.9	85.73
Number of living children		3,453	2.21 (1.34)
	≤ 2 children	2,434.6	69.18
	≥ 3 children	1,084.4	30.82
Partner's educational level	No education	350.0	9.95
	Primary	1,558.7	44.29
	Lower secondary	917.9	26.09
	Upper secondary	497.0	14.12
	Higher	195.3	5.55

Children's characteristics			
Child's age (months)		3,453	31.35 (16.82)
	< 6 months	272.0	7.73
	6-23 months	964.9	27.42
	24-59 months	2,282.2	64.85
Child's sex	Male	1,792.7	50.94
	Female	1,726.3	49.06
HAZ		3,453	-1.45 (1.30)
	Stunted	1,147.9	32.62
WHZ		3,453	-0.70 (1.12)
	Wasted	340.4	9.67
WAZ		3,453	-1.31 (1.06)
	Underweight	886.3	25.19

Note: Education categories represent the highest level of education attended, independent of the level completed. Survey sampling weights were applied

2. *Women's empowerment*

Older mothers (29-49 years) were significantly more highly empowered in resources (p<0.001), yet age was not significantly associated with agency (p=0.709) or achievements (p=0.382). (**Table 2**). Higher educational attainment was more highly associated with resources and achievement (p<0.001) and less so with agency (p=0.040). A significantly higher proportion of rural women were more highly empowered in terms of agency (p=0.002), whereas a significantly higher proportion of urban compared with rural women were more highly empowered in terms of achievements (p=0.049).

Thirty percent of women with children aged under six months scored high in achievements compared with fifty eight percent who scored high in agency and fifty two percent who scored high in resources. About sixty percent of mothers of children aged 24-59 months scored high on all three empowerment dimensions.

3. *Childhood undernutrition*

Table 3 shows that stunting was the most common form of childhood undernutrition (32.6%), followed by underweight (25.2%) and wasting (9.7%). Women's higher education (above secondary) was significantly protective of stunting (OR: 0.16; 95% CI 0.08-0.33) and underweight (OR: 0.17; 95% CI 0.07-0.44) but not wasting. Partner's higher education was also significantly protective of stunting (OR: 0.28; 95% CI 0.17-0.45) and underweight (OR: 0.31; 95% CI 0.19-0.53). Higher household wealth was protective of stunting (OR: 0.31; 95% CI 0.23-0.43) and underweight (OR: 0.33; 95% CI 0.24-0.45). Compared with children from urban areas, children living in rural households were significantly more likely to be stunted (OR: 1.77; 95% CI 1.36-2.32) and underweight (OR: 2.09; 95% CI 1.60-2.74).

4. *Women's empowerment and childhood undernutrition*

Tables 4, **5** and **6** present adjusted results of regressing childhood undernutrition by women's empowerment disaggregated by empowerment dimensions and undernutrition categories. Significant association is observed only between agency and underweight. Hosmer-Lemeshow indicated a good fit (GOF: p=0.366). (Table 6). The children of women with high agency scores were significantly less likely to be underweight after adjusting for women's education, wealth quintile, place of residence, number of living children, partner's education, and child's age and sex (AOR: 0.76; 95% CI 0.63-0.93).

5. *Geographic differences in women's empowerment and childhood undernutrition*

Appendix Table 1 shows the geographical distribution of the women's empowerment dimensions across Cambodia. Empowerment dimensions are separately shown in Appendix Figures 1, 2 and 3. High empowerment in resources was most prevalent in the province of Kandal (74.3%), followed by Siem Reap (71.3%) and Svay Rieng (71.1%). More than 90% of women living in Kampot and Kep had high agency whereas less than one in three women had high agency in Kampong Chhnang and Banteay Meanchey. Almost 73% of women living in Kampong Chhnang had high empowerment through their achievements. Women were least empowered in Preah Vihear and Stung Treng where only 43%, 38% and 42% of women were highly empowered in resources, agency, or achievements, respectively.

The distribution of childhood undernutrition in the Cambodian provinces is shown in Appendix Table 2 and illustrated in Appendix Figures 4, 5 and 6. The provinces Kampong Chhnang and Preah Vihear/Stung Treng were most badly affected by childhood undernutrition. The prevalence of stunting ranged from 16.3% in the capital Phnom Penh to 45.8% in Kampong Chhnang. Wasting was most prevalent in the provinces Preah Vihear and Stung Treng (14.1%) and least prevalent in Svay Rieng (5.2%). More than 40% of children in the study sample were underweight in Kampong Chhnang.

Table 2: Women's sociodemographic characteristics by dimensions of empowerment (N=3,453)

		Resources					Agency					Achievements				
		Low (%)		High (%)		p	Low (%)		High (%)		p	Low (%)		High (%)		p
Total (weighted, N=3,519)		1,375	(39.08)	2,144	(60.92)		1,181	(33.56)	2,338	(66.44)		1,589	(45.16)	1,930	(54.84)	
Women's characteristics																
Age	15-28 years	827	(44.10)	1,048	(55.90)	<.001***	635	(33.89)	1,240	(66.11)	.709	863	(46.03)	1,012	(53.97)	.382
	29-49 years	548	(33.36)	1095	(66.64)		545	(33.18)	1098	(66.82)		726	(44.18)	918	(55.82)	
Educational level	No education	228	(52.56)	206	(47.44)	<.001***	180	(41.58)	253	(58.42)	.040*	226	(52.20)	207	(47.80)	<.001***
	Primary	776	(40.08)	1,160	(59.92)		632	(32.63)	1,305	(67.37)		924	(47.71)	1,013	(52.29)	
	Lower secondary	267	(33.42)	532	(66.58)		259	(32.36)	541	(67.64)		332	(41.51)	467	(58.49)	
	Upper secondary	81	(31.19)	179	(68.81)		84	(32.15)	176	(67.85)		85	(32.73)	175	(67.27)	
	Higher	23	(25.60)	67	(74.40)		27	(29.72)	63	(70.28)		22	(24.72)	68	(75.28)	
Wealth quintiles	Poorest	379	(45.81)	448	(54.19)	.009**	262	(31.70)	565	(68.30)	.455	397	(48.02)	430	(51.98)	.024*
	Poorer	266	(38.07)	433	(61.93)		224	(32.07)	475	(67.93)		299	(42.75)	400	(57.25)	
	Middle	244	(36.36)	427	(63.64)		219	(32.68)	451	(67.32)		339	(50.56)	332	(49.44)	
	Richer	229	(35.76)	412	(64.24)		225	(35.03)	417	(64.97)		271	(42.33)	370	(57.67)	
	Richest	257	(37.76)	424	(62.24)		251	(36.81)	431	(63.19)		283	(41.52)	399	(58.48)	
Place of residence	Urban	206	(40.99)	296	(59.01)	.403	204	(40.71)	298	(59.29)	.002**	204	(40.65)	298	(59.35)	.049*
	Rural	1,169	(38.76)	1,847	(61.24)		977	(32.37)	2,040	(67.63)		1,385	(45.91)	1,632	(54.09)	
Number of children	≤2 children	981	(40.30)	1,453	(59.70)	.086	812	(33.37)	1,622	(66.63)	.762	1,111	(45.62)	1,324	(54.38)	.526
	3+ children	394	(36.34)	690	(63.66)		368	(33.97)	716	(66.03)		479	(44.13)	606	(55.87)	
Partner's educational level	No education	83	(23.75)	267	(76.25)	<.001***	127	(36.29)	223	(63.71)	.322	164	(46.89)	186	(53.11)	.034*
	Primary	531	(34.05)	1,028	(65.95)		488	(31.33)	1,070	(68.67)		736	(47.21)	823	(52.79)	
	Lower 2nd	397	(43.26)	521	(56.74)		320	(34.85)	598	(65.15)		406	(44.27)	512	(55.73)	
	Upper 2nd	266	(53.47)	231	(46.53)		172	(34.55)	325	(65.45)		220	(44.31)	277	(55.69)	
	Higher	98	(50.40)	97	(49.60)		74	(37.80)	121	(62.20)		63	(32.07)	133	(67.93)	
Children's characteristics																
Child's age (months)	<six months	130	(47.84)	142	(52.16)	.022*	114	(41.85)	158	(58.15)	.012*	191	(70.08)	81	(29.92)	<.001***
	6-23 months	396	(41.09)	568	(58.91)		350	(36.26)	615	(63.74)		453	(46.90)	512	(53.10)	
	24-59 months	849	(37.19)	1,434	(62.81)		717	(31.43)	1,565	(68.57)		946	(41.46)	1,336	(58.54)	
Child's sex	Male	735	(40.99)	1,058	(59.01)	.090	595	(33.17)	1,198	(66.83)	.671	814	(45.42)	978	(54.58)	.799
	Female	640	(37.10)	1,086	(62.90)		586	(33.96)	1,140	(66.04)		775	(44.90)	951	(55.10)	

* p<0.05 ** p<0.01 *** p<0.001

Notes:

p-values derived from corrected weighted Pearson chi square statistical tests (design based F-test).

Education categories represent the highest level of education attended, independent of the level completed. Weighted observations rounded to nearest integer. Survey sampling weights were applied.

Table 3: Women's sociodemographic characteristics by undernutrition outcomes (N=3,453)

		n	Stunting				Wasting				Underweight			
			%	p	OR	CI	%	p	OR	CI	%	p	OR	CI
Women's characteristics		3,519.0	32.62				9.67				25.19			
Age	15-28 years	1,875.1	31.23	.146	1.00	(ref.)	9.53	.829	1.00	(ref.)	24.10	.218	1.00	(ref.)
	29-49 years	1,643.9	34.20		1.14	(0.95-1.37)	9.83		1.04	(0.76-1.42)	26.42		1.13	(0.93-1.38)
Educational level	No education	433.4	41.39	<.001	1.00	(ref.)	11.71	.488	1.00	(ref.)	30.59	.005**	1.00	(ref.)
	Primary	1,936.8	34.46	***	0.74*	(0.56-1.00)	9.09		0.75	(0.49-1.16)	25.76		0.79	(0.58-1.07)
	Lower secondary	799.2	28.55		0.57**	(0.40-0.79)	10.16		0.85	(0.49-1.47)	24.34		0.73	(0.51-1.05)
	Upper secondary	259.7	24.49		0.46**	(0.29-0.73)	10.66		0.90	(0.48-1.68)	20.73		0.59*	(0.38-0.94)
	Higher	89.8	10.31		0.16***	(0.08-0.33)	5.37		0.43	(0.16-1.16)	7.16		0.17***	(0.07-0.44)
Wealth quintiles	Poorest	826.6	43.66	<.001	1.00	(ref.)	10.96	.121	1.00	(ref.)	33.60	<.001	1.00	(ref.)
	Poorer	698.9	37.41	***	0.77	(0.59-1.00)	12.04		1.11	(0.74-1.68)	29.14	***	0.81	(0.60-1.10)
	Middle	670.6	33.48		0.65**	(0.48-0.88)	8.56		0.76	(0.49-1.18)	26.57		0.72*	(0.53-0.96)
	Richer	641.1	26.29		0.46**	(0.34-0.62)	8.77		0.78	(0.50-1.22)	20.06		0.50***	(0.35-0.69)
	Richest	681.8	19.43		0.31***	(0.23-0.43)	7.63		0.67	(0.44-1.02)	14.39		0.33***	(0.24-0.45)
Place of residence	Urban	502.1	22.73	<.001	1.00	(ref.)	7.14	.022*	1.00	(ref.)	14.94	<.001	1.00	(ref.)
	Rural	3,016.9	34.27	***	1.77***	(1.36-2.32)	10.09		1.46*	(1.05-2.02)	26.89	***	2.09***	(1.60-2.74)
Number of children	≤2 children	2,434.6	30.43	.002**	1.00	(ref.)	9.43	.562	1.00	(ref.)	23.97	.068	1.00	(ref.)
	3+ children	1,084.4	37.53		1.37**	(1.12-1.68)	10.21		1.09	(0.81-1.47)	27.92		1.23	(0.98-1.53)
Partner's educational level	No education	350.0	44.21	<.001	1.00	(ref.)	12.48	.373	1.00	(ref.)	35.60	<.001	1.00	(ref.)
	Primary	1,558.7	36.01	***	0.71*	(0.53-0.95)	9.99		0.78	(0.52-1.16)	27.59	***	0.69*	(0.51-0.94)
	Lower secondary	917.9	29.61		0.53***	(0.38-0.74)	9.33		0.72	(0.45-1.15)	21.33		0.49***	(0.35-0.68)
	Upper secondary	497.0	25.10		0.42***	(0.29-0.61)	7.69		0.58	(0.34-1.00)	21.54		0.50***	(0.34-0.73)
	Higher	195.3	18.04		0.28***	(0.17-0.45)	8.75		0.67	(0.36-1.27)	14.76		0.31***	(0.19-0.53)
Children's characteristics														
Child's age (months)	<six months	272.4	14.96	<.001	1.00	(ref.)	13.57	.154	1.00	(ref.)	10.99	<.001	1.00	(ref.)
	6-23 months	964.9	25.14	***	1.91*	(1.16-3.14)	10.23		0.73	(0.44-1.19)	18.39	***	1.83*	(1.10-3.02)
	24-59 months	2,282.2	37.89		3.47***	(2.14-5.63)	8.97		0.63	(0.38-1.04)	29.75		3.43***	(2.18-5.40)
Child's sex	Male	1,792.7	32.51	.909	1.00	(ref.)	9.73	.924	1.00	(ref.)	23.47	.069	1.00	(ref.)
	Female	1,726.3	32.74		1.01	(0.85-1.21)	9.61		0.99	(0.74-1.32)	26.97		1.20	(0.99-1.47)

* p<0.05 ** p<0.01 *** p<0.001

Notes:

p-values derived from corrected weighted Pearson chi square statistical tests (design based F-test).

Odds ratios (ORs) result from logistic regression. CI= 95% confidence interval.

Education categories represent the highest level of education attended, independent of the level completed. Weighted observations rounded to nearest integer. Survey sampling weights were applied.

Table 4: Logistic regression of stunting by women's empowerment dimensions (N=3,453)

		COR	CI	AOR	CI
Resources composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.91	(0.76-1.10)	0.87	(0.72-1.07)
Agency composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.97	(0.81-1.17)	0.91	(0.75-1.10)
Achievements composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.88	(0.73-1.05)	0.85	(0.71-1.03)

*p<0.05;**p<0.01;***p<0.001
maximum VIF: 1.89
GOF: Resources 0.196; Agency 0.100; Achievements 0.061.
Notes:
VIF = variance inflation factor
GOF = Hosmer-Lemeshow Goodness-of-Fit
AOR= Adjusted odds ratio, CI= 95% confidence interval.
AOR: adjusted by women's education, wealth quintile, place of residence, number of living children, partner's education, and child's age.
Survey sampling weights were applied.

Table 5: Logistic regression of wasting by women's empowerment dimensions (N=3,453)

		COR	CI	AOR	CI
Resources composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	1.31	(0.94-1.80)	1.30	(0.94-1.79)
Agency composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.85	(0.62-1.16)	0.84	(0.61-1.15)
Achievements composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.86	(0.65-1.13)	0.86	(0.65-1.14)

*p<0.05;**p<0.01;***p<0.001
maximum VIF: 1.89
GOF: Resources 1.000; Agency 1.000; Achievements 1.000.
Notes:
VIF= variance inflation factor
GOF = Hosmer-Lemeshow Goodness-of-Fit
AOR= Adjusted odds ratio, CI= 95% confidence interval.
AOR: adjusted by place of residence. Survey sampling weights were applied.

Table 6: Logistic regression of underweight by women's empowerment dimensions (N=3,453)

		COR	CI	AOR	CI
Resources composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	1.03	(0.86-1.24)	0.97	(0.80-1.19)
Agency composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.85	(0.70-1.02)	0.76**	(0.63-0.93)
Achievements composite score	Low	1.00	(ref.)	1.00	(ref.)
	High	0.89	(0.73-1.09)	0.85	(0.69-1.04)

*p<0.05;**p<0.01;***p<0.001
maximum VIF: 1.89
GOF: Resources 0.070; Agency 0.366; Achievements 0.250.
Notes:
VIF= variance inflation factor
GOF = Hosmer-Lemeshow Goodness-of-Fit
AOR= Adjusted odds ratio, CI= 95% confidence interval.
AOR: adjusted by women's education, wealth quintile, place of residence, number of living children, partner's education, child's age, and child's sex. Survey sampling weights were applied.

Discussion

This study examines association between different dimensions of women's empowerment and child under-five undernutrition in a representative sample of 3,453 mother-child dyads in Cambodia. Women's empowerment in agency was shown to be associated with lower odds of underweight in their children. Agency speaks to women's decision-making power regarding their partner's income, health care, large household purchases and family visits. Mothers empowered in resources were more likely to have children who were wasted. Human capital and financial resources (e.g., education and household wealth) were associated with a lower prevalence of stunting and underweight.

The prevalence of stunting (32.6%), wasting (9.7%) and underweight (25.2%) was slightly higher than in the national data of the CDHS 2014 (32.4%, 9.6% and 23.9%, respectively) [32]. Minor differences are probably due to the selection of the study sample, which included the oldest anthropometrically measured child who may be more likely to be stunted or underweight. Also, our sample was less urban, slightly less educated and the wealthier quintiles were underrepresented compared with the total national CDHS sample (ibid). Undernutrition was most prevalent in the provinces Kampong Chhnang and Preah Vihear/Stung Treng and least common in the capital Phnom Penh. Although stunting was widespread in the province of Kratie, the child wasting prevalence was lower than average, suggesting that chronic and acute undernutrition do not have to occur collectively.

Like previous research in Cambodia [43, 44] we observe that stunting and underweight was more prevalent in socioeconomically deprived households, although the association was not significant for child wasting. Our analysis did not include information on access to improved water sources and sanitation, which has been shown to be positively associated with height-for-age in children aged 6-23 months living in the Cambodian province of Siem Reap [45]. In Cambodia, Sebayang et al. [37] showed that women's empowerment was positively associated with number of antenatal care visits, thus also describing a possible pathway to improve child health.

Women's empowerment is positively associated with their body-mass-index (BMI) [46]. According to a review by Wrottesley, Lamper and Pisa [47] a higher maternal BMI is linked with improved birthweight of children. Future studies could investigate whether maternal BMI mediates association between women's empowerment and childhood undernutrition.

Our study shows there is need for policies to mitigate both acute and chronic childhood undernutrition in Cambodia. Women's empowerment through agency was negatively associated with underweight and women's empowerment in achievements decreased the likelihood of stunting and underweight, although not statistically significant. Women are under-represented in higher education in Cambodia [33, 37]. Education above secondary level was most strongly associated with all dimensions of women's empowerment, with the lowest likelihood of child stunting and underweight. Policies are most urgently needed in the regions of Preah Vihear and Stung Treng where women's empowerment was lowest, and the prevalence of childhood undernutrition was high.

Strengths and limitations

Measuring women's empowerment remains challenging due to the lack of a consensus-based definition and because empowerment is an implicit construct. The limitations of using DHS data include the cross-sectional study design, which does not allow causal conclusions, and the possibility of bias due to self-report (e.g., social desirability and recall). It was not possible to measure all the relevant aspects of women's empowerment in these data, (e.g., experience of domestic violence, mother's time allocation towards childcare, mother's physical and mental health).

We were also unable to test for how women's empowerment might influence children's nutritional status through feeding practices, antenatal and postnatal care, child's birthweight, vaccination status, mother's physical and mental health and mother's nutritional status. Information regarding access to improved water sources and sanitation was not available. We recommend that future research investigates these factors as possible pathways to childhood nutrition.

The study's strengths are the use of a large sample of children aged from 0 to 59 months to provide a nuanced age-related understanding of contextual factors associated with child undernutrition in and across Cambodia's provinces. Cambodia, and indeed the South Asia Region, has not been given the same attention and donor support by Non-Government Organisations for child nutrition as countries in Sub-Saharan Africa [11]. This research helps to draw

attention not only to the Region, but to Cambodia, a country that lags behind its neighbours on both child undernutrition and gender issues [31).

The methodological approach, inspired by the valued work of Kabeer [38, 39], underpins our interpretation of women's empowerment as indicative of nuanced gender relations within a South Asian cultural context. The statistical results identify patterns and the tests of statistical significance indicate directions of association.

Overall, this study provides a basis for further research including longitudinal analyses to gain a more holistic dynamic understanding of the underlying complexities of child undernutrition and women's roles in Cambodia. It would also be interesting to investigate maternal dimensions regarding multiple children in the family, not just the most recent born.

Policy recommendations for Cambodia

Multi-sector structural interventions and developments are needed at national and sub-national levels to ensure that women are given fair and equal access to economic and social resources as a basis for self-determination. Harmful societal norms and gender stereotypes must be dismantled. Based on the study's findings, we present the following policy recommendations.

Access to learning and education is critical. This must start in early childhood. Parental support is crucial. Government incentives are needed to promote girls' retention in formal schooling at least to the secondary level. School programs should include informed discussion of gender issues for both boys and girls. Adolescent girls need to be mentored by 'successful' Cambodian women with career paths in a range of professions and vocations.

Workforce reforms are needed to increase women's participation in paid work and ensure that they have opportunities for upskilling and training in areas that align with what markets demand. Workforce retention is particularly important for women in childbearing years. Governments need to support employers in providing family-friendly workplaces and promoting workforce flexibility.

Jobs training needs to include skills adaptation for transitioning from the informal to the formal sector. The modern workforce requires technical literacy and flexibility for upskilling and re-training. Government policies are needed to encourage women's enrolment in science, technology, engineering, and mathematics subjects in secondary and tertiary education.

Social protection schemes are needed to support vulnerable women, many of whom are from poor households or reside in rural areas with limited access to educational and employment opportunities. Public and private sector investments are needed across agriculture, transport, water supply and sanitation, as well as education and employment. Targets must be set, and interventions evaluated. Improving women's empowerment will require understanding of their perceptions and experiences across time.

Conclusions

Maternal characteristics, attitudes and behaviours play a significant role in childhood undernutrition. Coping with poverty and facing societal and institutional barriers and gender biases inhibits womens' and girls' abilities to participate in educational and employment opportunities, derive benefits from those opportunities and exercise agency and independence. Structural change will occur slowly through reforms in education and employment but individual factors such as personal beliefs and resilience will help change negative attitudes and behaviours. Men and boys must be part of this transition which will ultimately benefit Cambodia's social and economic development [33].

Ethical Approval

The CDHS has been ethically reviewed and approved by the Independent Review Board under the auspices of the International Coach Federation. The data were provided to the authors in response to their written request.

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Authors Contributions

FT conceived the study, prepared the data, and undertook the analysis. JSW provided critical input. FT drafted a broad overview of the body of work which JSW used to prepare a first draft of the manuscript in collaboration with FT. JSW wrote the final version which was submitted to the Cambodia Journal of Public Health.

Declaration of Interest Statement

The authors acknowledge that they have no conflict of interest. No financial interest or benefit has arisen from this research.

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