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A Prevalence Analysis to Assess the Relationship between Maternal and Children's Nutritional Status in North-Western Rural China

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Abstract

Background: We know that in low- and middle-income countries maternal and children's under nutritional status is responsible for the advancement in deaths and other diseases. In this background, we structured this study in order to establish a relationship between maternal and children's nutritional status.

Methods: We conducted this prevalence analysis between December 2015 and February 2016 in North-Western rural China. We chose 2021 mothers of children (5 months < age ≤ 24 months) as study subjects. Standard and calibrated methods and techniques were used to measure the weight and height of mothers and horizontal lengths of children.

Results: We calculated the Z-scores of 'weight for height' (WfH), 'weight for age' (WfA) and 'height for age' (HfA) and found that the values were less than -2 for 8.2%, 10.5% and 12.6% children, respectively. In the bivariate analysis, we found association between nutritional status of children and maternal anthropometrical features. We found correlation between HfA Z-score of children with maternal height (r=0.27; P=0.006) and also between WfH Z-score of children and maternal educational background (r=0.32; P=0.001) and body mass index (r=0.22; P=0.018). Relatively better Z-scores of WfA and WfH (P<0.001 for both the cases; after multivariate analysis) for children of mothers having salary were also found. Besides, a strong association between maternal characteristics (height and body mass index) and Z-scores of HfA (P=0.012) and WfH (P=0.042) of children was also achieved.

Conclusion: Interestingly, maternal good nutritional status and good salary have been found to be beneficial for children's nutritional status. This kind of relationship between maternal and children's nutritional status concludes that for the betterment of mother and child's health, maternal nutritional status as well as her guaranteed financial empowerment should be improved.

Keywords: Prevalence analysis; Maternal; Children; Nutrition; North-Western rural China

Introduction

In recent years, it has been estimated that the under nutrition status of mother and her child is highly responsible for the one-third children disease burden and around 5 million deaths in a year. This condition is even worse in low- and middle-income countries and consequently, under nutritional status of mother and child found responsible for advancement in overall disease burden and deaths. Besides, it has also been evidenced by scientific community that maternal nutritional status is very important for better health of the mother as well as for better and healthy growth and development of the child. Thus the crucial role of maternal nutritional status cannot be neglected [1,2]. In the similar fashion, association between maternal and child under nutrition with human capital and risk of adult diseases in various low-income and middle-income countries has been reviewed and revealed that damaged suffered in early life leads to premature impairment and will affect future generations [3].

In general, an employed woman contributes to the household income and thus indirectly contributes to the nutrition of the family and overall, enhances her nutritional status. This happens because after getting employment a woman's power and status improve automatically and she may spend her earned money on gaining nutrition due to preferential inclusion of health and nutrition related spending from household earnings [4]. In this way the employment status of woman boosts the child's welfare and thus helps in improving the worldwide policies of development agencies related to the development of children's health and the economic empowerment of women [5]. Specifically, the Malaysian children's status is very bad with respect to unemployed status of mothers [6]. Moreover, a study to reveal relationship between multiple micronutrients and nutritional status among school children [7] has helped us in the fight against the malnutrition problem among children.

In addition to this, the effect of maternal education on children's health has also been explored by researchers. It was found that maternal educational status is strongly linked with the health of the children because children of less educated mothers have more malnutrition problems in comparison to those children whose mothers have good education. Hence a strong association between maternal educational status and children's nutritional status has been revealed in several countries [8-10]. In addition to this, a study, related to Ghana, to establish a relationship between nutritional knowledge of mother

and nutritional status of the child implied that mother's knowledge about nutrition is more essential than other formal education with respect to improvement in nutritional status of the child [11].

To the best of our knowledge, our study is the first study of its own kind to assess the relationship between maternal and children's nutritional status in under-developed region of China i.e. in North-Western rural China. We aimed this work in order to fight against the malnutrition problem in this region of China.

Materials and Methods

The complete study was approved by Ethical Review Committee of Xian Children's Hospital. Besides, we also informed to the authorities in the respective localities about the purpose and objectives of our study. We also explained the advantages of our study to the mothers and then they gave oral consent. For the noble cause we referred the malnourished children whose condition was severe to the health facilities in their respective localities and also informed this to the children's parents.

Survey area and method design

The baseline survey area was chosen from North-Western rural China in the form of Qinghai and Gansu provinces. These provinces are mostly rural and have high land area for farming purpose. The prevalence analysis was conducted between December 2015 and February 2016. Total 2021 mothers of children (5 months<age<24 months), living in these two provinces were chosen randomly as study subjects. Total 79 women have declined to participate due to their personal (unknown) reasons. We took one precaution in this selection that we chose only those mothers who were residing in the study area for more than 6 months. We got written/oral consent of all the subjects.

Questionnaire and Anthropometric measurements

In order to estimate the socio demographic features of the mother and of the family, we performed a structured pretested questionnaire for baseline survey. First, we developed the questionnaire in English with the assistance of process validation and then translated it into Zhongyuan Mandarin language. We used principal component analysis for the estimation of the maternal wealth and got 22 items having 0.7 unit value of Cronbach's alpha. With the assistance of well trained staff, the height (horizontal length in case of children) and weight of both mother and children were measured during the baseline survey. We used standard and calibrated methods and techniques for anthropometric measurements. Seca medical 770 personal scale balances were used to measure the weight of barefooted children wearing light (weight) shirt (least count was 0.1 kg). With the help of a length-measuring board the horizontal length was measured to the nearest 0.1 cm.

Data analysis

The statistical data analysis software SPSS (v16.1) was used after entering the data followed by checking the missing values and outliers. WHO Anthro software was used for the conversion of heights, ages and weights of children to respective Z-scores (i.e. HfA, WfH and WfA). For linear regression models variables with respect to demography, socio-economy, education and anthropometry were selected with the help of significant Pearson's correlation coefficients. Only those variables which were significantly associated ($p<0.200$) in the bivariate analyses were subjected to multivariate analyses in order to predict the children nutritional status. In all the cases, $P<0.050$ was considered as statistically significant.

Results

Maternal social, demographic, economic and household characteristics

The results related to the study of maternal social, demographic and household factors with respect to rural areas of North-Western Chinese provinces: Qinghai and Gansu are shown in Table 1. All the mothers were married. Most of the mothers have Han (Muslim religion) ethnicity (72.4%) and they were not the head of the family in most of the cases (94.9%). Besides, there were other ethnicities such as Hui and Tibetian mothers in effective population. More than 50% mothers were far behind their formal education (57.4%). A large number of mothers had earning based on agriculture (32.3%) but most of the mothers were unemployed (63.8%). They drink tap water (61.5%) provided by community source and 18.1%children had priority for food at mealtime (meal priority). The wealth status of the families were mostly (64.3%) in medium level. A large number of families were living bamboo wall made houses (74.9%) with roof made of thatched grass (75.3%). For amusement purpose mothers listened radio in 17.9% cases and they watched television in 28.7% cases. It is important to note here that we didn't find any variation in the results with respect to variations in ethnicity (or religion) in two provinces.

Characteristics	Specific Factors	Participants	
		(Percentage frequency of total)	
		Qinghai province	*Gansu province*
		(n = 1010)	(n = 1011)
Ethnic status	Han (Muslims)	561 (27.8%)	902 (44.6%)
	Hui	161 (8.0%)	50 (2.5%)
	Tibetian	212 (10.5%)	39 (1.9%)
	Dongxiang	-	20 (0.9%)
	Tu	40 (2.0%)	-
	Mongol	18 (0.9%)	-
	Salar	18 (0.9%)	-
Main employment	Salaried-Yes	38 (1.9%)	41 (2.0%)
	Salaried-No	647 (32.0%)	643 (31.8%)
	Agriculture based	325 (16.1%)	327 (16.2%)
As head of family	Yes	50 (2.5%)	53 (2.6%)
	No	960 (47.5%)	958 (47.4%)
Education	Primary	348 (17.2%)	342 (16.9%)
	Secondary	58 (2.9%)	52 (2.6%)
	No formal education	577 (28.6%)	582 (28.8%)
	Preparatory	17 (0.8%)	21 (1.0%)

	Others	10 (0.5%)	14 (0.7%)
Tap water as water	Yes	610 (30.2%)	633 (31.3%)
source	No	346 (17.1%)	432 (21.4%)
Meal priority	Men	739 (36.6%)	746 (36.9%)
	Women	28 (1.4%)	32 (1.6%)
	Children	180 (8.9%)	185 (9.2%)
	Others	60 (2.9%)	51 (2.5%)
Wealth level	Low	319 (15.8%)	310 (15.3%)
	Medium	644 (31.9%)	655 (32.4%)
	High	44 (2.2%)	49 (2.4%)
House-wall	Mud and wood	249 (12.3%)	258 (12.8%)
	Bamboo	762 (37.7%)	752 (37.2%)
House-roof	Iron sheet	157 (7.8%)	172 (8.5%)
	Thatched grass	766 (37.9%)	756 (37.4%)
	Bamboo	90 (4.5%)	80 (3.9%)
Amusement	1. Radio-Yes	178 (8.8%)	184 (9.1%)
	Radio-No	820 (40.6%)	839 (41.5%)
	2. Television-Yes	299 (14.8%)	280 (13.9%)
	Television-No	702 (34.7%)	740 (36.6%)

Table 1: Maternal socio-economic and socio-demographic factors of the households (n = 2021).

Anthropometric characteristics and relation with nutrition

Maternal and children's anthropometric characteristic features and its relation with children's nutritional status are shown in detailed Table 2. Half of the mothers (49.2%) were between the age of 26 years and 30 years, almost one-fourth (23.3%) mothers were in the range of 30-35 years and 20.4% mothers were 21-25 years old. Body mass index of most (84.7%) of the mothers were 18.6-25 kg/m^2 while 13.9% mothers had body mass index below 18.6 kg/m^2. More than half (51.8%) of the children were female and most (65.0%) of the children were 13-24 months old. For a large number (10.2%) of children the Z-score of weight for height (WfH) were below -2. Besides, 11.7% children were below -2 Z-score of height for age (HfA) and 6.9% children were below -2 Z-score of weight for height (WfH).

Anthropometric characteristics	**Specific features**	**Participants (Percentage frequency of total)**	
		Qinghai province	*Gansu province*
Maternal age (in years)	16-20	25 (1.2%)	28 (1.4%)
	21-25	203 (10.0%)	210 (10.4%)
	26-30	493 (24.4%)	502 (24.8%)
	30-35	233 (11.5%)	239 (11.8%)
	≥36	40 (1.9%)	48 (2.4%)
Maternal height (in cm)	≤145	165 (8.2%)	170 (8.4%)
	145.1-150	143 (7.1%)	140 (6.9%)
	150.1-155	241 (11.9%)	246 (12.2%)
	155.1-160	328 (16.2%)	311 (15.4%)
	≥160.1	138 (6.8%)	139 (6.9%)
Maternal body mass	≤18.5	140 (6.9%)	141 (7.0%)
Index (in kg/m2)	18.6-25	869 (43.0%)	843 (41.7%)
	25.1-30	6 (0.3%)	5 (0.3%)
	30.1-35	9 (0.5%)	8 (0.4%)
Children's gender	Female	522 (25.8%)	525 (26.0%)
	Male	483 (23.9%)	491(24.3%)
Children's age	8-Jun	181 (9.0%)	183 (9.1%)
(in months)	12-Sep	165 (8.2%)	179 (8.9%)
	13-24	654 (32.4%)	659 (32.6%)
Nutritional status of	<-2 WfA (underweight)	105 (5.2%)	102 (5.0%)
Children (in Z-score)	<-2 HfA (stunting)	117 (5.8%)	119 (5.9%)
	<-2 WfH (wasting)	69 (3.4%)	71 (3.5%)

WfA: Weight for Age; HfA: Height for Age; WfH: Weight for Height

Table 2: Maternal and Children's anthropometric features (n = 2021).

Correlation between maternal characteristics and children's nutritional status

Pearson correlation coefficient values with respect to establish the correlation between maternal characteristics and children's nutritional status is shown in Table 3. Maternal education (r=0.32, P=0.001) and maternal body mass index (r=0.22, P=0.018) were correlated with children's Z-score of WfH. On the other hand, maternal height (r=0.27, P=0.006) was correlated with children's Z-score of HfZ.

	Size of the family	Maternal education	Main employment	Children's gender	Maternal body mass index	Maternal height	Source of water	Maternal weight	WfH*	HfZ*

Size of the family	1									
Maternal education	0.432									
Main employment	0.079	0.151								
Children's gender	0.112	0.129	0.059							
Maternal body mass index	-0.031	0.141	-0.051	-0.049						
Maternal height	-0.072	0.011	0.117	0.094	-0.078					
Source of water	-0.014	0.022	0	0.017	-0.019	0.059				
Maternal weight	0.069	0.223	0.079	0.031	0.561	0.473	0			
WfH*	0.159	-0.241	0.131	0.15	0.169	-0.02	0.061	0.129		
HfA*	0.058	-0.003	0.141	0.161	-0.009	0.197	0.151	0.107	-0.094	
WfA*	0.151	0.172	0.192	0.219	0.119	0.131	0.069	0.161	0.662	0.683
*Z-scores; WfH: weight for height; HfA: height for area; WfA: weight for area; coefficient values are calculated as Pearson correlation coefficient.										

Table 3: Correlation coefficient values for maternal features and children's nutritional status.

Anticipation of children nutritional status

Table 4 shows the identification of anticipators of Z-scores of WfH, WfA and HfA of the children by using stepwise regression analysis. We entered all socio demographic and anthropometric features of the mothers which were significant at P<0.2, into the models. The Z-score of WfH of the children were significantly predicted by normal maternal body mass index and salaried (either from private job or from government job) employment features. However, we found negative association between Z-score of WfH of the children and maternal illiteracy (P=0.037). Additionally, we also found significant association between Z-score of WfA of the children and salaried employment of mother. On the other hand, a significant association was found between Z-score of HfA of the children and maternal height. We found association between Z-score of HfA of the children and tap water source in bivariate analysis but not in multivariate analysis.

Z-scores of	P-value	β-coefficient value	95% Confidence Interval (CI)
WfH!			
Fixed factor	0.009	-0.627	-1.081 and -0.172
Maternal body mass index*	0.005	0.635	0.201 and 1.061
Maternal salaried employment	0.002	1.053	0.461 and 1.639
Maternal illiteracy	0.037	-0.371	-0.703 and -0.037
WfA@			
Fixed factor	0.008	-0.304	-0.519 and -0.079
Maternal age#	0.039	-0.667	-1.258 and -0.053
Maternal salaried employment	<0.001	1.342	0.771 and 1.915
Gender (male)	0.02	-0.373	-0.679 and -0.061
HfA^			
Fixed factor	0.057	-0.391	-0.781 and -0.008
Maternal age#	0.031	-1.084	-2.028 and -0.127
Maternal salaried employment	0.024	1.163	0.169 and 2.138
Maternal height$	0.024	0.637	0.99 and 1.159
!R2 = 13.9%; *18.6 to 25.0 kg/m2; @R2 = 15.8%; #≥36 years; ^R2 = 9.9%; $≥156.9 cm; Maternal salaried employment (Yes = 1 and No = 0); Gender (Male = 1 and Female = 0)			

Table 4: Anticipator of Z-scores of WfH, WfA and HfA of the children.

Discussion

We designed this baseline survey for the North-Western rural China, specifically for Qinghai and Gansu provinces. We found that normal maternal body mass index (18.6 to 25.0 kg/m^2) predicted Z-score of WfH and thus we can also say that children's nutritional status was predicted by maternal anthropometry feature. The reason behind this outcome lies in the fact that mothers in middle and low wealth classification had lower body mass indices in comparison to mothers in high wealth classification (P<0.001).

A correlation between maternal body mass index with education and income was shown in an African country's study [12]. A study to

explore the micronutrient deficiencies and nutritional characteristics of diets of the children in several countries discovered that the quality of diet rather than its quantity plays the key role and hence it should be improved to overcome malnutrition [13]. In a South-American country, Brazil significant impact of maternal height and weight on children's nutritional status was achieved when a study was performed in its day-care center [14]. In our present study for North-Western rural China, we also found similar type of results in which maternal education feature was found be a positive anticipator for Z-score of WfH of the children. This can be explained on the fact that maternal education is directly proportional to their visit to healthcare centre and which is directly proportional to nutritional advice from health professionals and thus we can say that a highly educated mother is more prone to get healthy advice from professionals/doctors. Another advantage of maternal well education is that they are more feasible to get salaried employment and that will definitely enhance their purchasing and decisive power and this will directly improve children's nutritional status.

In our prevalence analysis we found that Z-scores of all the three: weight for height (WfH), weight for age (WfA) and height for age (HfA) of children were strongly anticipated by salaried (either from private job or from government job) employment feature. A Brazilian cross-sectional study showed that maternal lower household income yielded lower mean Z-score of HfA among children [15]. It is also important to note that besides the wealth of a household, maternal owned wealth may play a crucial role as it may help her buying various food which in result improve the diet diversity of the family. Thus financial empowerment of mothers could be an essential step to improve children's nutritional status. Similar result has been reported in a low income area of a Central-American country in which a correlation between Z-score of WfA and WfH of children and maternal wealth were observed [5]. However, in this study it was observed that Z-score of WfH of children were affected by their maternal employment status. Moreover, in a study in Malaysia, weights of children were positively correlated with the working hours of their mothers [6]. Besides, another study of similar kind among an African country's women and their children nutritional status [16] revealed that children's growth in regions were associated with working status of the mother with significant and positive impact but with high levels of malnutrition and this outcome was further complimented and supported by another study [17]. Mechanism of this correlation between maternal employment and child development revealed that employed women spend significantly less time with their children's educational activities and this cannot be offset by husband [18].

In our study Z-score of height for age of children were anticipated by maternal height feature (≥156.9 cm). This may be happened because of the fact that over the growth period children's linear growth is influenced by height of the mother as reported elsewhere [19]. Another study revealed that after the adjustment of socioeconomic status, the Z-scores of HfA of children were significantly lower when their mothers had lowest tertile of height in comparison to those children whose mothers had highest height tertile [20]. In our work, the Z-score of weight for height (WfH) showed that 10.2% children were underweight. Besides, Z-scores of height for age (HfA) and weight for height (WfH) showed that 11.7% children were stunting and 6.9% children were wasting. Thus we found a correlation that enhancement in maternal height was significantly associated with lower odds of stunting because we found significant enhancement in Z-score of HfA of the children with enhancement in maternal height. This result is quite consistent with a previous work on maternal nutrition studies in an African country [21]. Interestingly, in our findings, there was a negative association between Z-score of HfA of the children and the paternal guardianship. Similar kinds of results were obtained previously in African countries where the mean Z-score values of females were consistently higher than those of males [22].

We found negative association between Z-scores of WfA and HfA of the children and the older maternal age (≥ 36 years age) in our study. The probable reason behind this might be the less health conscious nature of older mothers in comparison to younger mothers. It is important to note here that this is not a linear relationship as we found that youngest mothers (16-20) were also not health conscious. Our result is quite consistent with the World Bank report which said that children born to mid-late twenties aged mother were least prone to malnutrition [23]. Additionally, children of the teen mothers and late thirties aged mothers are significantly more likely to suffer with malnutrition.

Our prevalence analysis has large sample collection data and thus it tells the complete story of relationship between maternal and children nutritional status in North-Western rural China, especially, Qinghai and Gansu provinces. Thus it would not be very difficult to generalize our results with reference to other rural provinces of North-Western China. Another advantage of our study is that it outcomes less probable causal relationships between the nutritional status of mother and child.

In conclusion, we can say that well educated and better salaried employed mother provides a better nutritional status to their children. On the other hand, Z-scores of HfA and WfH of the children were significantly associated with height of the mother and normal body mass index of the mother, respectively. The inter-connection between the nutritional status of mother and child stresses that improvement in the mothers' nutritional status would definitely lead to improved health outcomes of both the mothers and their children.

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