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EFFECT OF EARLY CHILDHOOD MALNUTRITION ON TOOTH ERUPTION SEQUENCE IN NEPALESE CHILDREN

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ABSTRACT

Child under-nutrition has effects which last a lifetime. The consequences can be both short term and long term. Malnourished children tend to be physically, emotionally and intellectually less productive and suffer more from chronic illnesses and disabilities compared to healthy children.

The objective of this study was to determine prevalence of under-nutrition and investigate association between early childhood malnutrition and deciduous tooth eruption in children aged 0-59 months in Mugu district of Nepal. A structured questionnaire based on Nepal Demographic and Health Survey 2011 questionnaire was used. Weight and height of 246 children, aged 0-59 months were measured. Dental caries status and eruption sequence were noted. Among the total, 14 .1% had moderate/severe wasting of muscles, 25.2% were moderately stunted and 36.6% were severely stunted. From the total, 30 .5% were moderately underweight and 18.3% were severely underweight. A significantly higher proportion with wasting presented with delayed eruption sequence than those without wasting ($p<0.05$). From the total, 25.4% who presented with delayed eruption also had at least one decayed tooth ($p<0.05$). From this study, it was concluded that malnutrition causes delayed tooth eruption, affects the oral health of the child, and results in an increased caries experience.

Keywords: dental caries - stunting - tooth eruption sequence - underweight - under - nutrition - wasting.

INTRODUCTION

Nutritional status can be defined as the physiological condition of an individual that results from the balance between nutrient requirements and intake and the ability of the body to use these nutrients. Under-nutrition

is a condition in which the body does not have enough of the right kind of food to meet its energy, macronutrient (proteins, carbohydrates and fats) and micronutrient (vitamins and minerals) needs. Both under- and over-nutrition are forms of malnutrition (Pridmore & Hill 2009).

Under-nutrition in early childhood can result in behavioral problems, deficient social skills and even a lower Intelligence Quotient. The short and long term effects of under-nutrition include delayed developmental milestones, an increased risk of infections and greater susceptibility to chronic disease as an adult (Smith, Ruel & Ndiaye 2005). Child under-nutrition is believed to be a consequence of the complex interactions between socio-demographic, environmental, reproductive, institutional, cultural, political and regional factors (Islam *et al.* 2013).

Under-nutrition is responsible for greater than a third of under-five child deaths in the world. It is associated with approximately 60% of mortality among children under 5 years in Sub-Saharan Africa (Kandala *et al.* 2011). Also, those undernourished children who survive have to put up with profound negative impact of their nutritional status converting their lives into a cycle of under-nutrition, frequent bouts of illness and decreased learning ability (Hien & Kam 2008).

Under-nutrition in Nepal

According to the National Demographic and Health Survey (NDHS 2016) of Nepal, proper nutrition is vital for the growth and development of children. Early childhood is important for optimal physical, mental and cognitive growth, health and development. Unfortunately, this period is often marked by protein-energy and micronutrient deficiencies that interfere with optimal growth (Ministry of Health, Nepal 2017).

Mortality among children in Nepal has seen a decline in the last fifteen years and the expectation is that the 'Millennium Development Goal (MDG) Four' will be achieved before time (UNDP 2015). Figures from the National Demographic and Health Survey (NDHS) 2011, NDHS 2006, NDHS 2001, Nepal Family Health Survey (NFHS) 1996 and the first national nutrition survey in 1975 conducted in Nepal show no significant reduction in child under-nutrition in the last 35 years (MOHP Nepal 2007, MOHP Nepal 2002, Pradhan *et al.* 1997, Brown 1968). During this period, many strategies, programs and policies to improve the nutritional status of

children have been implemented with limited success, as shown in Figure 1.

Data from the NDHS 2016 shows that 36 percent of children under age 5 are stunted, and 10 percent of children are wasted. 27 percent of children under age 5 are underweight (Ministry of Health, Nepal 2017).

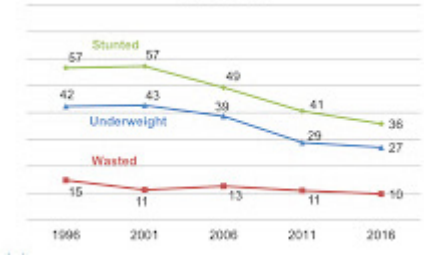

Figure 1: Percentage of children under age 5 who are malnourished.

Prevalence of under 5 child under-nutrition in Mugu was reported to be the highest among districts in Nepal in the Annual Health Report (2010). Prevalence was calculated only on the basis of weight for age (Services DoH 2011). Weight for Age or underweight alone cannot give a clear picture of the prevalence of acute and chronic forms of malnutrition as this indicator cannot distinguish between wasted and stunted respectively. Therefore, it does not present a complete profile of under-nutrition trends in Mugu.

The rationale behind this study was to provide a complete and updated profile of under-nutrition among children aged 0-59 months in Mugu and to find an association between under-nutrition and eruption sequence of deciduous teeth.

MATERIALS AND METHODS

This cross-sectional study was conducted over a period of 2 months (July – August 2018). Mugu district lies in the Mid-Western Development Region, is a part of Karnali zone, and is one of the seventy-five districts of Nepal. It covers an area of 3,535 km² and has a population of 55,286. Mugu is known for being both the most remote district in Nepal, as well as the least developed. Some 46.5 % of people in the Mid-Western Region live below the poverty line. Mugu District comprises 24 Village Development

Committees (VDCs), and a single electoral constituency, with its District Headquarters (DHQ) in the town of Gamgadhi in Shree Nagar VDC (MOHP Nepal 2012).

The lack of physical infrastructure presents a major challenge to accessibility and service delivery; the only transportation options are limited to unreliable flights which are beyond the means of most people. Talcha airport is located 5km from Gamgadhi. Within the district, narrow mule trails that are difficult to use during the monsoon season raise the cost of transporting food and other goods to up to four times above normal levels (MOHP Nepal 2012).

The participants comprised of 246 children aged 0-59 months residing in wards in at least 80 households in the 2 selected VDCs of Mugu district. Multistage sampling method was used to select the subjects.

The weight of children aged 0-59 months and their mothers was measured using Seca weighing scales with digital screens designed and manufactured under the authority of the United Nations Children's Fund (UNICEF). Height/length of the participants was measured using measuring boards specially produced by Shorr Productions for use in survey settings. The official Nepalese version of the NDHS 2011 structured questionnaire was used in the field (MOHP Nepal 2012). Dental caries assessment was done and eruption status was noted.

Anthropometric data was used to calculate three indices: weight-for-age, height-for-age, and weight-for-height. New growth standards published by the World Health Organization (WHO) in 2006 was used to calculate the nutritional status of a child. The new standards were established from data collected in the WHO Multicenter Growth Reference Study (MOHP Nepal 2012). Descriptive statistics was calculated for mean and frequency. Chi square test was done to test for association between the variables (p value < 0.05 was considered significant).

RESULT

The results showed that Mugu district has a very high incidence and prevalence of under-nutrition. Associated factors were poor access to food, bad hygienic practices and poor environment, reduced level of child care by mother because of an increased work load and little knowledge of good practice of feeding (Sharma 2012).

The prevalence of wasting, stunting and underweight in the sample population is described in terms of frequency and percentage as shown in Table 1. These three indices were expressed in standard deviation units from the Multicenter Growth Reference Study median of the WHO reference population.

In terms of Weight for Height, 14.1% were moderately or severely wasted. In terms of Height for age, 25.2% were moderately stunted and 36.6% were severely stunted. In terms of Weight for age, 30.5% were moderately underweight and 18.3% were severely underweight.

Table 1: Prevalence of Wasting, Stunting and Underweight

Indicator	Level	Frequency	Percentage (%)
Weight for Height (Wasting)	Normal (≥ -2 SD)	210	85.4
	Wasted (<-2SD & ≥ -3SD)	21	8.5
	Severely Wasted (< -3SD)	15	6.1
	Total	246	100
Height for Age (Stunting)	Normal (≥ -2 SD)	94	38.2
	Stunted (<-2SD & ≥ -3SD)	62	25.2
	Severely Stunted (< -3SD)	90	36.6
	Total	246	100
Weight for Age (Underweight)	Normal (≥ -2 SD)	126	51.2
	Underwt. (<-2SD & ≥ -3SD)	75	30.5
	Severely Underwt. (< -3SD)	45	18.3
	Total	246	100

The overall prevalence of stunting (61.8%) is higher in the study, in comparison to NDHS 2016 which reports 36% to be stunted and 12% to be severely stunted (Ministry of Health, Nepal 2016) reiterating the fact that Mugu district has the highest levels of under-nutrition in the country (Ministry of Health, Nepal 2016, Services DoH 2011). Children perceived to be small at birth had the highest prevalence of stunting (68.7%). which was similar to the NDHS 2016 findings (Ministry of Health, Nepal 2016).

The prevalence of underweight children was highest (69.8%) among mothers with low BMI (<18.5) (Table 1). Children perceived to be small or very small at birth had a higher prevalence (66.6% and 80% respectively) of being underweight. The odds of a child perceived to be small at birth to be underweight was 7.124 compared to a child perceived to be large at birth. Both findings were similar to the NDHS 2016 findings (Ministry of Health, Nepal 2016). Children who had suffered from an episode of diarrhea had a higher prevalence of underweight (67.7%) in the study. The positive association between acute episode of diarrhea and underweight among

children was also seen in a study conducted among Malawian children aged 6-18 months which reported greater prevalence of underweight in children who had suffered from fever or diarrhea. These children were not exclusively breastfed, and contamination from other food products were likely sources of contamination which led to frequent episodes of diarrhea (Weisz *et al.* 2011). According to our findings, a Dietary Diversity Score of 3-4 and 0-2 was associated with a higher prevalence of underweight children (48.5% and 66.6% respectively).

We found an association between under-nutrition, tooth eruption sequence and dental caries as well. In our study, a significantly higher proportion with wasting presented with delayed eruption sequence than those without wasting ($p<0.05$). Furthermore, 25.4% who presented with delayed eruption also had at least one decayed tooth ($p<0.05$).

DISCUSSION

Keeping in mind the high prevalence of stunting in the study population it is important to discuss some of the consequences it has. The (2008) Lancet series on Maternal and Child Under-nutrition found that stunting in the first two years of life was associated with lower levels of school attainment and reduced economic productivity in adult life. Stunting between 12 and 36 months was associated with poor cognitive performance and/or lower grades in school (Victora et al. 2008). Prospective cohort studies consistently show significant associations between stunting by age 2 or 3 years and later cognitive deficits, school achievement, and dropout. Early childhood stimulation has been shown to reduce the negative impact of stunting on cognitive outcomes, with lasting effects (Walker et al. 2007).

The protective influence of Growth Monitoring Visits against stunting and under-nutrition as a whole was also seen in a study which evaluated 16 projects which involved Growth Monitoring and Growth Monitoring Promotion impact over the past 3 decades. The study reported a significant reduction in rates of stunting (Liu *et al.* 2017). Low Food Security Score was also found to be associated with higher levels of stunting in a study which surveyed 800 households in 8 countries, including Nepal, among children aged between 24 to 60 months (Psaki *et al.* 2012). The association between low Dietary Diversity Score and stunting was also seen in a study which analyzed data from DHS surveys of 11 countries including Nepal. The study reported significant associations between low Dietary Diversity Scores and stunting in 9 out of the 11 countries (Arimond & Ruel

2004). Similarly, the Nepal Thematic Report on Food Security and Nutrition 2013 showed children with a score of less than 4 had a higher prevalence of stunting (76.2%) and stated that there was a significant association between Dietary Diversity Score and stunting among children (Institute IFPR 2014).

In the bivariate analysis, the following independent variables: Maternal BMI, Food Security Score, Child Size at Birth, History of Diarrhea and Dietary Diversity Score were found to be significantly associated with Underweight among children. The lack of education among mothers is also a risk factor for the prevalence of severe malnutrition and this was reported in a study done in Ghana (Rikimaru *et al.* 1998).

People need a variety of foods to meet requirements for essential nutrients, and the value of a diverse diet has long been recognized. In the context of many developing countries, monotonous diets based on a very small number of foods contribute to micronutrient malnutrition, particularly in rural areas. Beyond meeting needs for essential nutrients, diverse diets are increasingly recognized as playing a role in the prevention of some chronic diseases. However, while there is consensus among nutritionists that dietary diversity is good, there are a large number of unanswered questions about the definition and measurement of diversity, and about the relationships among diversity, nutrient adequacy, and outcomes such as child nutritional status (Arimond & Ruel 2004).

An association between delayed exfoliation of primary teeth and delayed eruption of permanent teeth as well as stunting was reported with Early Childhood-Protein Energy Malnutrition in a study done in Haitian adolescents. This interpretation has practical significance in interpreting age-specific dental caries data from populations with different malnutrition experiences. As tooth eruption involves both maturation of the tooth and ability of overlying bone to reform allowing tooth eruption, factors that negatively affect these processes may delay eruption (Psoter *et al.* 2008).

A study done in Nepal reported severe bone maturation delay and 'small stature' as a result of lifelong community dietary deficiency. 21% of the study population showed delayed eruption patterns with respect to permanent teeth (Fleshman 2000). However, there is no published data in Nepal on eruption sequence of deciduous teeth and dental caries associated with under-nutrition.

The importance of proper nutrition cannot be over-emphasized. The global "nutrition transition" to junk food in early years of childhood has

compounded the risk for poor oral health and malnutrition among children. Proper nutrition in the early years of life greatly reduce the prevalence and severity of caries, mouth pain and caries-related malnutrition (Sokal-Gutierrez *et al.* 2016). Malnutrition and dental caries in early childhood remain persistent and intertwined global health challenges, particularly for indigenous and geographically-remote populations. Parent-reported mouth pain was associated with severe caries, and mouth pain interfering with sleep was predictive of poor nutritional status. This relationship was most prevalent in children aged 3-6 years in a study done in the Ecuadorian Amazon region . This study also revealed that poor/ reduced sleep quality increases energy expenditure, activates hormonal responses, which in turn, affect appetite, food consumption, and activation of inflammatory processes that contribute to chronic disease. Severe tooth decay in early childhood is a substantial risk factor for malnutrition (So *et al.* 2017).

Malnutrition, affects oral health, and poor oral health, in turn, may lead to malnutrition. Malnutrition may alter the homeostasis (ability of an organism or environment to maintain a state of internal balance and physical well-being in spite of changes or outside factors), which can lead to disease progression in the oral cavity, reduce the resistance to the microbial biofilm and reduce the capacity of tissue healing. It is not just sugar alone that causes cavities, it's the lack of nutrients that weaken the teeth. Insufficient calcium promotes tooth decay. Even if enough calcium is consumed, the body needs enough Vit. D to be able to absorb it (Sheetal *et al.* 2013). A study done in a pediatric population in India reported that dental caries status and delayed eruption were found to be more in malnourished groups as compared to the normal group (Singh *et al.* 2018).

However, a study done in Sudan demonstrated that there is little measurable effect of sustained malnutrition on the average timing of tooth formation. Nutritional deficiencies may influence the skeletal as well as the dental development (maturity) because the role of nutrition for oral tissues may not be different from that for other tissues and organ systems. Teeth (tooth formation) have substantial biological stability and are insulated from extreme nutritional conditions compared to other maturing body systems. Malnutrition has been proven to have a greater negative impact on skeletal development than growing teeth (Elamin & Liversidge 2013).

Benefits from the study

The participants in the study gained knowledge regarding correct infant and young child feeding practices, the importance of immunization and growth monitoring of children and good reproductive health practices like antenatal care (ANC) visits during pregnancy and appropriate birth spacing as the interviewer counseled the participants about the topics mentioned above at the end of the session.

The results from the study further highlight the high prevalence of under-nutrition in Mugu district which should serve as an indicator to national policy makers to step up interventions to combat both acute and chronic under-nutrition.

CONCLUSIONS

The prevalence of under-nutrition among children aged 0-59 months in Mugu district is high as reflected by the indices of wasting, stunting and underweight. The situation regarding factors such as dietary diversity and food security which were linked to more than one indicator of under-nutrition needs to be resolved through infrastructure development and intervention programs. Factors such as birth spacing, growth monitoring visits, high levels of fever and diarrhea among children can be resolved through adequately staffed health facilities and outreach programs with a special focus on health education and promotion.

The study also concludes that under-nutrition could further be responsible for delayed eruption sequence of teeth and dental caries. Thus, the findings from this study could be utilized to generate hypothesis for future research.

REFERENCES

Arimond, M. & Ruel, M.T. (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *J Nutr,* **134**(10): 2579-2585. https://doi.org/10.1093/jn/134.10.2579. PMID: 15465751.

Brown, M. L. (1968). Health survey of Nepal: Diet and nutritional status of the Nepalese people. *American Journal of Clinical Nutrition,* **21**(8): 875-81.

Elamin, F. & Liversidge, H. (2013). Malnutrition has no effect on the timing of human tooth formation. *PloS One,* **8**: e72274. https://doi.org/10.1371/journal.pone.0072274

Fleshman, K. (2000). Bone age determination in a paediatric population as an indicator of nutritional status. *Trop Doct,* **30**(1):16-18. https://doi.org/10.1177/004947550003000109.

Hien, N. N. & Kam, S. (2008). Nutritional status and the characteristics related to malnutrition in children under five years of age in Nghean, Vietnam. *Journal of Preventive Medicine and Public Health,* **41**(4):232-240.

International Food Policy Research Institute (IFPRI). (2014). *2013 Global food policy report.* Washington, D.C.: International Food Policy Research Institute (IFPRI) http://dx.doi.org/10.2499/9780896295629

Islam, M. M., Alam, M., Tariquzaman, M. et al. (2013). Predictors of the number of under-five malnourished children in Bangladesh: application of the Generalized Poisson Regression Model. *BMC Public Health,* **13**: 11. https://doi.org/10.1186/1471-2458-13-11.

Kandala, N. B., Madungu, T. P., Emina, J. B., Nzita, K. P. & Cappuccio, F. P. (2011). Malnutrition among children under the age of five in the Democratic Republic of Congo (DRC): does geographic location matter? *BMC Public Health*, **25**: 11:261. https://doi.org/10.1186/1471-2458-11-261.

Liu, Q., Long, Q. & Garner, P. (2017). Growth monitoring and promotion (GMP) for children in low and middle income countries. *The Cochrane Database of Systematic Reviews*, **1**: CD010102. https://doi.org/10.1002/14651858.CD010102.pub2.

MOHP. (2002). *Nepal demographic and health aurvey 2001.* Ministry of Health and Population Nepal and ICF International Inc. Kathmandu, Nepal.

MOHP. (2007). *Nepal demographic and health survey 2006.* Ministry of Health and Population, Kathmandu, Nepal.

MOHP. (2012). *Nepal demographic and health survey 2011.* Ministry of Health and Population Nepal and ICF International Inc. Kathmandu, Nepal.

MOHP, New ERA, & ICF. (2017). *Nepal Demographic and Health Survey 2016.* Ministry of Health and Population, Nepal, New ERA; and ICF. Kathmandu, Nepal.

Pradhan, A., Aryal, R. H., Regmi G., Ban, B. & Govindasamy, P. (1997). *Nepal family health survey 1996.* Kathmandu, Nepal and Calverton, Maryland: Ministry of Health Nepal, New ERA, and Macro International Inc.

Pridmore, P. & Hill, R. C. (2009). Addressing the underlying and basic causes of child undernutrition in developing countries: What works and why? *S.L.: Ministry of Foreign Affairs of Denmark.*

Psaki, S., Bhutta, Z. A., Ahmed, T. *et al.* (2012). Household food access and child malnutrition: results from the eight-country MAL-ED study. *Popul Health Metrics,* **10**: 24. https://doi.org/10.1186/1478-7954-10-24

Psoter, W., Gebrian, B., Prophete, S., Reid, B. & Katz, R. (2008). Effect of early childhood malnutritionon tooth eruption in Haitian adolescents. *Community Dent Oral Epidemiol,* **36**(2):179-189. https://doi.org/10.1111/j.1600-0528.2007.00386.x

Rikimaru, T., Yartey, J. E., Taniguchi, K., Kennedy, D. O. & Nkrumah, F. K. (1998). Risk factors for the prevalence of malnutrition among urban children in Ghana. *J Nutr Sci Vitaminol,* **44**(3):391-407.

Services DoH. (2011). *Annual Report 2066/67 (2009/2010).* In: Department of Health Services MoHaPN, editor. Kathmandu, Nepal.

Sharma, K. R. (2012). Malnutrition in children aged 6-59 months in Mugu district. *J Nepal Health Res Counc.,* **10**(21):156-159.

Sheetal, A, Hiremath, V. K., Patil, A. G., Sajjansetty, S. & Kumar, S. R. (2013). Malnutrition and its oral outcome – a review. *J Clin Diagn Res,* **7**(1):178-180.

Singh, N., Bansal, K., Chopra, R. & Dharmani C. K. K. (2018). Association of nutritional status on salivary flow rate, dental caries status and eruption pattern in pediatric population in India. *Indian J Dental Sciences,* **10**(2):78-82.

Smith, L. C., Ruel, M. T. & Ndiaye, A. (2005). Why is child malnutrition lower in urban than rural areas? Evidence from 36 developing countries. *World Development,* **33**(8):1285-1305.

Sokal-Gutierrez, K., Turton, B., Husby, H. et al. (2016). Early childhood caries and malnutrition: baseline and two-year follow-up results of a community-based prevention intervention in Rural Ecuador. *BMC Nutr,* **2**:73. https://doi.org/10.1186/s40795-016-0110-6

So, M., Ellenikiotis, Y. A., Husby, H. M., Paz, C. L., Seymour, B. & Sokal-Gutierrez, K. (2017). Early childhood dental caries, mouth pain, and malnutrition in the ecuadorian amazon region. *Int J Environ Res Public Health,* **14**(5): 550. https://doi.org/ 10.3390/ ijerph14050550.

UNDP. (2015). The millennium development goals eight goals for 2015. http://www.np.undp.org/content/nepal/en/home/mdgoverview/.

Victora, C. G., Adair, L., Fall, C. et al. (2008). Maternal and child undernutrition study group. Maternal and child undernutrition: Consequences for adult health and human capital. *Lancet,* **26**: 371(9609):340-57. https://doi.org/ 10.1016/S0140-6736(07)61692-4.

Walker, S. P., Wachs, T. D., Gardner, J. M. et al. (2007). Child development: risk factors for adverse outcomes in developing countries. *Lancet,* **13**: 369(9556):145-157. https://doi.org/10.1016/S0140-6736(07)60076-2.

Weisz, A., Meuli, G., Thakwalakwa, C., Trehan, I., Maleta, K. & Manary, M. (2011). The duration of diarrhea and fever is associated with growth faltering in rural Malawian children aged 6-18 months. *Nutr J.,* **20**: 10(1):25. https://doi.org/10.1186/1475-2891-10-25.