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Research Article

# Trends in Malnutrition Indicators from Birth to Adolescence in Rural KOKAN Region of Western India

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**Abstract**

In India non-communicable diseases contribute substantially to disease burden. Infectious diseases and under-nutrition are also widespread. Inadequate nutrition is the major cause of morbidity as well as mortality in Indian children. Prevalence of underweight and stunting is high. We assessed anthropometric morbidity (underweight, stunting and wasting) among children from 0 (at birth) to 18 years of age in Dervan area of KOKAN region.

**Methods:** Data on anthropometric measurements (height, weight, BMI) of 32138 children was collected over a period of 8 years as a part of various holistic education programs run by the hospital in the surrounding communities. The nutritional status of children was assessed using WHO definition of low birth weight, stunting, underweight and wasting.

**Results:** At birth Prevalence of low birth weight and wasting remained similar over 3 successive years (43%, 46% and 42%) but that of stunting decreased (49%, 41% and 37%) and underweight increased (25%, 33%, 33%). During early and late childhood the prevalence of stunting continued to increase, while that of underweight and wasting continued to decrease over a period of 8 years. Stunting was on the rise while underweight was on decline in adolescence over a period of 8 years.

**Conclusion:** Almost one third of children in DERVAN area were underweight and stunted. For the attainment of best possible nutrition and growth in children, there is a need to develop strategies which are short term (nutritional interventions and reducing the risk factors) as well as long term (poverty reduction and improved food security)

**Keywords:** Rural; Malnutrition; Low birth weight; Stunting; Underweight

## Abbreviations

NCD: Non Communicable Diseases; DOHaD: Developmental Origins of Health and Disease; LBW: Low Birth Weight

## Introduction

The well-known anthropometric markers of under-nutrition (underweight, wasting and stunting) in children form a major burden in developing countries [1]. Under-nutrition in childhood results in poor growth. Associations of poor childhood growth with risk of Non-Communicable Diseases (NCD) and morbidity as well as mortality in later life are well known. The major factors contributing to under-nutrition are insufficient food quantity, food quality, food unavailability, improper feeding practices and infectious diseases [2,3]. Insufficient food intake or infective episode results in wasting [4] but continued exposure of these for longer period results in stunting [5]. Infant and childhood malnutrition continue to pose a major threat to young children in India [6]. According to the Developmental Origins of Health and Disease (DOHaD) hypothesis [7], developing organism changes its physiology and structure as an adaptive response to environmental insults, thus predisposing it to many adverse health conditions in adult life. Thus, poor nutrition in early life induces structural and functional changes in organs like brain, liver, and pancreas which will manifest as NCD in adult life.In most of the studies testing DOHaD hypothesis, birthweight was used as a surrogate marker for fetal under nutrition and birth weight and the results showed the inverse association of birthweight with risk of type2 diabetes in adult life [8]. Ultimately these Low birth weight infants grow to become undernourished and stunted children. The global rise in the prevalence of obesity and type2 diabetes is often attributed to changes in diet (frequent consumption of calorically dense foods) and sedentary lifestyles (physical inactivity) [9]. Epidemiological studies in humans [10] and animal studies [11] have now shown that nutritional insults in early life affect metabolic and physiological functions throughout life. An evaluation of childhood growth provides useful insights into the nutrition and health situation not only of individuals but also of entire population groups. It demonstrates how such data, when used judiciously, can permit the identification of risk groups, contribute to the development of appropriate food and nutrition policies, and serve as a baseline against which change over time can be realistically evaluated.

### Setting and location

BKL Walawalkar Hospital was established in 1996 in the hilly area at the base of Western Ghats in the village 'Dervan' of Ratnagiri district in the western Indian state of Maharashtra, India. It falls in the coastal region of KOKAN of western India. The mission of the hospital is to provide comprehensive health services to the rural


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**Table 1:** Summary of various community programs.

| Community program | Medical service | Holistic service |
|---|---|---|
| Maternal health | Weekly Antenatal clinics in villages and house hold visits Hospital based prenatal & antenatal investigations, delivery | Post marriage counselling. Antenatal care and health education,importance of hospital delivery. Free supplements of nutritious food and medicines. |
| Child health | Weekly daycare centre (*Anganwadi*) visits in villages for health check up and anthropometry.<br>Health education & immunization clinics at hospital<br>Residential camps in hospital for severely undernourished children | Education about child growth, stay of 15 days at hospital for undernourished children. Distribution of locally prepared nutritious supplements. Nutritonal food preparation demonstrations |
| School children health | School based dental screening program & medical examination.care. Undernourished and children with dental caries were brpoght to the hospital for treatment. | Education about importance of dental health. Distribution of tooth pastes and tooth brushes. |
| Adolescent health | School and college based anthropometry and testing for anemia. Residential camps at hospital for medical checkup and gynecological,ophthal,dermatological and dental consultations. | Four day stay at hospital. Counselling on sexuality, menstruation, menstrual hygiene. |

**Table 2A:** Years of data collection.

| Measurement window | Age | Years of data collection | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Birth | 0y | | | | | | | | |
| Infancy and childhood | 0-5y | | | | | | | | |
| Late childhood | 6-10y | | | | | | | | |
| Adolescence | 11-19y | | | | | | | | |

Shaded cells represent years when data was collected

**Table 2B:** Number of anthropometric data points by years (Total n=32138).

| | | Numbers | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measurement window | Age | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total | Girls, Boys (%) |
| Birth | 0y | | | | | | 709 | 713 | 925 | 2347 | 50.1, 49.9 |
| Infancy and childhood | 0-5y | | | | 578 | 363 | 566 | 764 | 773 | 3044 | 51.9, 49.1 |
| Late childhood | 6-10y | 159 | 2732 | 2640 | 2995 | 570 | 373 | 188 | 134 | 9791 | 52.1, 47.9 |
| Adolescence | 11-19y | 429 | 3332 | 3375 | 5261 | 945 | 1993 | 1130 | 501 | 16956 | 83.4, 16.6 |
| | | | | | | | | | | Grand total 32138 | 31.6. 68.4 |

Shaded cells represent number of subjects on whom data was collected

community. Farming is the main occupation of the villagers. Rice is the only harvest. The villages have poor access to highways. Power supply is inadequate.Essential food supplies are accessible in the local weekly market common to many villages. In general, the inhabitants are socio-economically backward.The hospital has developed a network with various government agencies, children's daycare centers in the villages (known as *Anganwadi*), primary health centers, and schools from the district to implement various community programs. The hospital runs all the community programs with a holistic approach. Over the last 20 years, the hospital has also acquired many advanced technologies that provide state of the art medical care at affordable rates to the rural population that surrounds the village of Dervan. Thus, the hospital provides comprehensive holistic services along with advanced medical care while taking into consideration the local social and cultural practices. All these services (medical as well as holistic) are offered free of cost. (Table 1) Since 1996 the hospital has collected a substantial amount of data regarding various health related parameters. Earlier all the data was in paper format but since 2011 it has started to maintain the data on digital platforms. Data on anthropometric parameters (height, weight, and BMI) was routinely collected as a part of various holistic programs. Using these parameters, indices for anthropometric morbidity such as Low Birth Weight (LBW), stunting, wasting, and underweight were generated. The prevalence of these indices indirectly reflects not only health but also the nutritional status of the population (Table 2A&2B).

Hence, with a specific objective of estimating the prevalence of these indices, we analyzed our data which has been collected over the last 8 years (2011-2018) as a part of the various community programs.

## Materials and Methods

The holistic programs covered 155 schools and colleges and 250 *Anganwadi* from total 242 villages. Height was recorded to the nearest 0.1 cm using wall mounted or portable stadiometers. In the age group birth to 2 years, length was measured on infantometer and subsequently on stadiometer and recorded as height in centimeters. In the hospital setting, weight was measured on an electronic scale. When the data was collected in daycare centers, weight was measured on a digital scale that was carried to the field by the hospital staff. Height was measured using the wall mounted stadiometers in the daycare centre. Measurements were done in the presence of either of the parents or a caretaker in the daycare centre. BMI was calculated.

### Ethics

During the data collection process verbal consent was sought

from either of the parents or the caretaker. We obtained the permission of our institute ethics committee to analyze this data. Our institute ethics committee is registered with the Government of India. Registration code of the committee is EC/755/INST/MH/2015/RR-18. Prior to 2016, verbal consent was sought from either of the parents or the caretaker. Subsequently, we started taking informed written consent from either of the parents/caretaker.

### Calculations and classifications

In order to simplify the interpretations of the results we have divided the data into 4 categories based on the age at measurement. These are birth, infancy and childhood (up to 5 years), late childhood (6-10y), and adolescence (11-19y). Low Birth Weight (LBW) refers to weight at birth <2500 gm.We used the WHO definition to define stunting (height Z-score<−2), underweight (BMI Z-score<−2), and wasting (weight-for-height Z-score<−2) in our data [12-14].

### Statistical methods

We have presented the anthropometric morbidity (LBW, stunting, underweight and wasting) using proportions. Trends in morbidity spanning the timeframe of the years of data collection were analyzed. The analysis was done using statistical software SPSS 25.0. When some subjects had multiple observations due to their attendance at different holistic programs at various ages, we took the first available observation into consideration. Thus, all the data points are cross sectional and not longitudinal.

## Results and Discussion

The gender distribution was even in all the measurement windows except adolescence, where it was heavily tilted towards the girls. This was due to various community programs which exclusively focused on adolescent girls. At birth, prevalence of LBW and wasting remained similar over 3 successive years (2016-2018). It was (43%, 46%, and 42%, p=0.30) for LBW and (23%, 28%, and 26%, p=0.22) for wasting respectively (Figure 1). Stunting decreased (49%, 41%, and 37%, p=0.0000) while underweight increased (25%, 33%, and 33%, p=0.003). During early childhood and late childhood (Figure 2) prevalence of stunting continued to increase (p=0.000 for both), while that of underweight and wasting continued to decrease (p=0.000 for both).In adolescence stage stunting was on the rise (p=0.003 for trend) while underweight was on the decline (p=0.000) (Figure 3).

We have presented the data on anthropometric morbidity collected in rural KOKAN area over 8 years period. At birth Prevalence of low birth weight and wasting remained similar over 3 successive years, but that of stunting decreased and underweight increased. During early and late childhood the prevalence of stunting continued to increase, while that of underweight and wasting continued to decrease .Stunting was on the rise while underweight was on decline in adolescence.

While the representativeness of our data may be questioned, we would like to clarify that our hospital is located at Dervan village but the community programs with holistic approach cover the entire district of Ratnagiri. Women who delivered at our hospital came from the entire geographic region of the district. There are many shortcomings in our data. It is cross sectional and prone to survival bias. Decrease or increase in various prevalence estimates

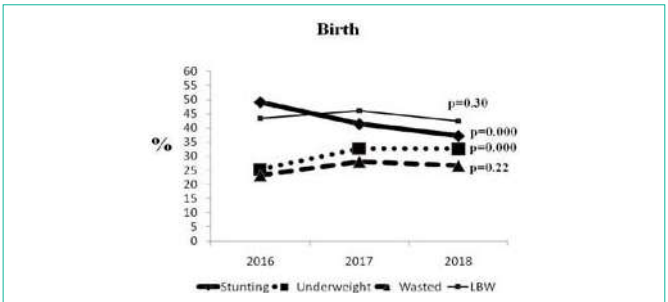



**Figure 1:** Trend in prevalence of stunting, underweight, wasting and low birthweight over 3 years (2016-2018).

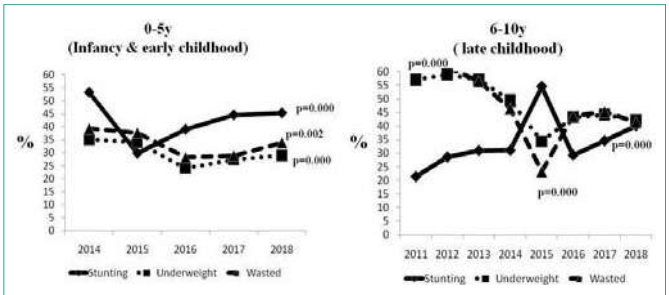



**Figure 2:** Trend in prevalence of stunting, underweight, wasting in infancy, early childhood (2014-2018) and late childhood (2011-2018).

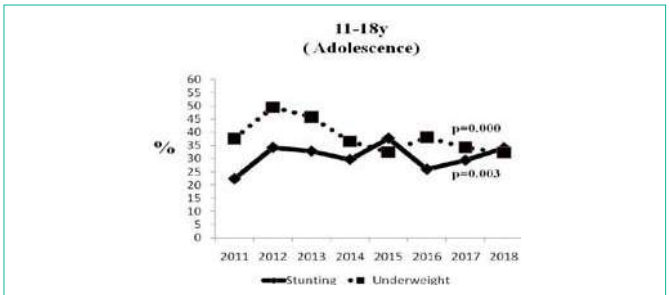



**Figure 3:** Trend in prevalence of stunting and underweight in adolescence over 8 years ( 2011-2018).

of anthropometric morbidities over the years has been shown to be statistically significant but how much of it could be attributed to holistic treatment component of our hospital or is it just a chance finding cannot be answered here. There are a lot of confounders (education, income, family size, diet, and feeding practices etc.) which play a vital role in individual growth and thus will eventually reflect in the anthropometric morbidity in the community. But we have not measured these. Also, we have not recorded chronic and acute morbidities that may affect anthropometric measurements. We have taken only the 1st available observation. With all these shortcomings, a question about the generalizability and applicability of our results could be raised.Only a new prospective longitudinal cohort study will overcome these shortcomings. However, despite being cross sectional and temporal in nature, the results, although only descriptive in nature, are indeed alarming. National Family Health Survey (NFHS-4) conducted by the Indian government in 2015-16 [15] in Ratnagiri district where our subjects come from, reported stunting, wasting and underweight prevalence estimates of 27-28%, 30%, and 29% respectively in under 5 years of age children.

Anthropometric morbidities have been reported in many parts

of the world.A report from Ghana in Africa [16] found 17.9% prevalence of stunting and 4.7% that of wasting among preschool children. A study from South Africa among under 5 year old children [17] also found very low prevalence of stunting (7.6%) and wasting (3.8%). Our estimates in 0-5 year old children are very high.A cross sectional study in Malaysia among children and adolescents of 5 different ethnicities including Indians found a stunting prevalence ranging from 13% to 18% [18].Prevalence of stunting among those with Indian ethnicity was only 13% which was very low compared to us. There are some reports from other parts of India.A study in the rural area of Indian state of West Bengal reported stunting prevalence of 43% [19] which is similar to our findings.A study with a sample size of more than half million households covering 640 districts in the country reported stunting prevalence of 38.4% with a wide range of variation of (12.4% to 65%) across districts [20]. This variation was explained by low BMI. Global burden of disease study [21] reported the trend in malnutrition indicators from every state of India from 1990 to 2017. In 2017 the national prevalence was 21.4% for LBW, 39.3% for stunting, 15.7% for wasting, and 32.7% for underweight. Figures for the state of Maharashtra were 19.8%, 33.1%, 18.7%, and 30.3 % respectively. Thus, except underweight all other indicators in our study have very high prevalence when compared to national and state prevalence. Inadequate diet and poor maternal education were the major determinants of stunting in a four South Asian nations study which included India [22]. A report on infants from South Asia including India [23] identified minimal diet frequency as the major cause. Young lives study from the state of Andhra Pradesh reported maternal height as a determinant of stunting recovery [24].A study in the state of Maharashtra among 0-23 months old infants found prevalence of 22.7% and LBW was the major determinant of stunting [25]. Our data has also shown a decrease in prevalence of underweight over the years, but still the prevalence remains very high in the range of 30%-35% in childhood and adolescence. According to a recent report about pooled analysis of 2416 populations around the World, prevalence of moderate and severe underweight was highest in India, at 22•7% among girls and 30•7% among boys [26].In our report also prevalence of all anthropometric morbidities is very high ranging from 25% to 40%. This reinforces the presence of under nutrition not only in pregnancy (reflected by LBW) but also in the postnatal stages characterized by stunting, wasting, and underweight. Considering the well known associations of these morbidities with adult diseases, results in our area are alarming. Focused efforts to reduce these morbidities should be made by improving the living environment and nutrition.

Recent epidemiological studies show that diabetes mellitus is also prevalent in undernourished populations, despite the virtual absence of obesity (a major determinant in well nourished populations). Under nutrition in itself may be a risk factor in these populations. The glucose intolerance of protein-energy malnutrition is known to impair the beta cell function and in substantial proportion of undernourished subjects it is irreversible despite nutritional rehabilitation. There is also a possibility of genetic and environmental influences increasing the susceptibility to type 2 diabetes [27]. Our hospital is situated at a remote village. A study on diabetic patients in our hospital clinic showed that those who were underweight or normal using BMI criteria had significantly lower body fat percentage, higher muscle mass percentage, lower visceral fat and lower basal metabolic rate when compared to those who were overweight [28]. A survey of adolescent girls from rural schools showed 64% prevalence of underweight [29]. Another cross sectional community based study in our area carried by us on 80 adolescent rural girls of age group 10 to 16 years showed the prevalence of low BMI was 77.5%, that of anemia was 22.5%, and a high prevalence of many micronutrient deficiencies [30]. The data from our hospital on fetal ultrasounds found a lag in the fetal growth beyond 32-33 weeks of gestation which was attributed to poor maternal nutritional status [31]. These findings highlight the poor nutritional status of the community studied across the various stages of life cycle. Our current data analysis has also reconfirmed this fact. Under nutrition is a major cause of morbidity and mortality among young children and adolescents in India. India also has 1/3rd of the stunted children in the world [20]. Our analysis though cross sectional shows that anthropometric morbidity before adulthood may have its origins in the fetal period, suggesting a need to intervene early, ideally with interventions known to reduce intrauterine growth restriction and preterm birth. There is an urgent need to establish intervention programs, for nutrition, and to improve the standard of living.

## Conclusion

We have estimated the prevalence of malnutrition indicators in Dervan area. The measured indicators are very high compared to state level or national level data. Only a prospective longitudinal study will answer whether long term health interventions are effective in curbing this rise.

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