

# The Effectiveness of Dietetics Intervention in Young Children with Failure to Thrive

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**Distributed under** Creative Commons CC-BY 4.0**Keywords** Failure to thrive; Medical nutrition therapy; Pediatrics; Growth and development**Abbreviations** FTT: Failure to Thrive; NUH: National University Hospital; WHO: World Health Organisation MGRS: Multicentre Growth Reference Study; WV: Weight Velocity; HV: Height Velocity; NHG: National Healthcare Group

## Abstract

**Purpose:** The objectives of this study are to determine the change in growth centile z-scores and to determine the growth velocity differences between intensive dietetic intervention and standard care over a 6-month period in children less than two years of age, medically diagnosed with Failure to Thrive (FTT) and seen by a dietitian.**Methods:** This is a retrospective service evaluation of paediatric dietetic inpatient and outpatient services between January 2012 and January 2014 at the National University Hospital (NUH) in Singapore.**Findings:** There was an improvement in mean weight and height z-scores over the 6-month period, with significant larger improvements in mean weight z-score for the intensive intervention compared to standard care. Multidisciplinary team intervention and coexisting medical disorders were associated with significant changes in weight velocity.**Conclusions:** Dietetic intervention is beneficial, especially in children with medical co morbidities. Multidisciplinary team intervention and control of underlying medical illnesses may also provide additional improvement in growth.

## Introduction

Nutrition in the early years, particularly in the first 1000 days of life [1], plays an important role in growth and development [2]. A balanced protein energy supplementation across the lifespan affects nutritional status in utero, in children and in adulthood [3,4]. Poor nutrition in infancy may lead to Failure to Thrive (FTT) or faltering growth [5], which has significant short-term and long-term consequences. Being underweight (i.e. having a low weight compared to that expected for a well-nourished child of the same age and sex) in children less than five years of age was responsible for the largest disease burden and death globally in 2004 [5]. Emotional, cognitive and psychological deficits have also been reported later on in life [6-8] as a result of under-nutrition and FTT.

A quantitative assessment of a child's growth will involve comparing his or her growth velocity data against age-appropriate reference standards [9,10]. The ideal would be growth standards derived from trends of growth in local children, as the average growth of a child varies by country and race. The last anthropometric study undertaken in Singapore in 1988 involved 13,500 children aged zero to six years, and showed that local children were in fact smaller, lighter and had smaller head circumferences than their American counterparts [11]. Unfortunately, the primary data from this study necessary to obtain objective estimates, such as z-scores, of growth are not available (personal correspondence).

Another option is the latest World Health Organisation (WHO) velocity growth standards [12]. They are based on data collected as part of the WHO Multicentre Growth Reference Study (MGRS) [13]. The WHO MGRS from 1997-2003 was undertaken in six different countries (United States of America, Oman, Norway, Brazil, Ghana and India), which included 8440 healthy breastfed infants and young children of term gestation ( $\geq 37$  weeks,  $\leq 42$  weeks) without significant medical comorbidity, to develop growth standards for children below five years of age [14].

Paediatric dietitians are able to utilise knowledge specific to children, to assess their nutritional risks and dietary needs. The dietitian is then able to provide appropriate nutritional support and personalised dietary advice for children with FTT [15,16]. However, the effectiveness of paediatric dietitians has not been studied extensively in South East Asia, specifically in Singapore.

Therefore, we sought to determine the effect of dietetic follow up on the growth of children aged less than two years. We hypothesise that more frequent dietetic intervention has a positive effect on the growth centiles of children with failure to thrive, regardless of the cause.

## Methods

### Patients

This was a retrospective audit of all children with FTT seen by the paediatric dietetic inpatient and outpatient services at NUH between 1<sup>st</sup> January 2012 to 31<sup>st</sup> January 2014. NUH is a tertiary hospital sited within the community, with dedicated paediatric and dietetic wards as well as outpatient services. Thus the children seen have a spectrum of co-morbidities as they come from both community referrals as well as inpatient referrals.

Children enrolled into this study had to meet all of the following inclusion criteria:

- Born between the years 2010-2014 and be of term gestation ( $\geq 37$  weeks,  $\leq 42$  weeks)
- Aged less than 18 months at the first dietetic review
- Diagnosed by a physician to have failure to thrive or faltering growth
- Had at least one encounter with any dietitian in NUH
- Had growth centiles available for review three to nine months after that initial encounter with the dietitian.
- Residing in Singapore for more than six months after the initial dietetic visit

Children were excluded if they had any known genetic defects or if the mother had uncontrolled diabetes mellitus during that pregnancy, as normal growth curves may not apply to them.

### Dietetic follow-up

The standard practice for dietetic intervention in children with failure to thrive is as follows: the physician refers the child to the dietitian for targeted nutritional counselling. At the initial visit, nutritional assessment and advice is given to patients and/or their caregivers and a follow up appointment is recommended one month later.

At the subsequent follow up visit, weight and length gain are evaluated. If the rate of weight gain is not meeting catch up targets, additional assessment and counselling to address the likely causes are provided, and a two to four week follow up is then recommended. Conversely, if catch up targets are met, a one to two month follow up is given. This scheduling protocol is followed until the child is able to achieve weight and length centiles that are within two centiles of his or her birth centiles. No follow up calls are made to the families if appointments were missed.

As frequent intervention may have an effect on growth, we divided the patients into two groups to evaluate this: standard care versus intensive dietetic intervention. The intensive care group consisted of patients attending four or more dietetic visits over a six-month period; the standard care group consisted of patients who attended three or less visits over the same period.

### Data collection

The data collected were as follows:

- Demographics (examples: ethnicity, gender, housing type)

- Presence of medical comorbidities
- Number of visits offered as well as attended by the patient. Compliance rate with visits is calculated as a percentage of the total number of offered visits.
- Consultations with a multidisciplinary feeding team, defined as two or more health professionals involved in feeding. These health professionals are the paediatrician, speech therapist, dietitian and child psychologist.
- Length of follow up
- Age, Weight and Height/Length at first visit and at six months after the first visit
- Calorie and protein intake at first and final visit
- Estimated calorie and protein requirements at each visit

Weights were taken using a Seca 757 baby scale (accurate to two decimal places) and naked weights where possible. Length measurements were taken using a Seca 416 Infantometer, which measures a child's lying position. These measures were plotted on standard local growth curves, together with all past measurements of weight and length since birth, to determine if the child was growing appropriately. Z-scores of these parameters were obtained by comparison with the WHO charts.

The 24-Hour Diet Recall (24-HDR) was used to obtain an estimate of the typical dietary intake. Although this method is subjective, it has recognised as an acceptable short term assessment of dietary intakes in several studies [17]. It is quick to administer and can provide detailed information on foods [18,19]. Estimations of calorie and protein intakes based on the 24-HDR was calculated using a nutrition software program (Food Works Professional 7) at each visit. Estimated calorie requirements were based on this formula [20]:  $\text{kcal/kg} = (120 \times \text{ideal weight for height (kg)}) / (\text{actual weight (kg)})$ . Estimated protein requirements for 'catch-up' growth were calculated at approximately 9% of energy requirements [21].

### Statistics

SPSS for Windows (version 20) was used. The backward and forced entry methods of regression were performed simultaneously and compared to determine the best predictive model for change in z-scores per month for Weight Velocity ( $Z\Delta WV$ ) and Height Velocity ( $Z\Delta HV$ ) for the study population. All of the variables (housing type, gender, ethnicity, presence of medical comorbidities, presence of each of the specific medical disorders, number of visits to the dietitian, compliance with offered visits, presence of multidisciplinary team intervention, meeting of calorie target at first visit, meeting of protein targets at first visit, meeting of calorie targets at final visit, meeting of protein targets at final visit) were input into the regression analysis. Chi square tests and Mann Whitney U tests were used in accordance with the distribution of data points to compare baseline data, primary and secondary outcomes between standard care and intensive dietetic intervention groups.

### Ethics

This study was approved by the National Healthcare Group (NHG) Domain Specific Review Board.

## Results

A total of 37 patients that fulfilled the inclusion and exclusion criteria and seen by dietitians between 1<sup>st</sup> January 2012 to 31<sup>st</sup> January 2014 were included in the study. Table 1 shows the baseline characteristics of the study cohort.

Cardiac defects were the most common medical comorbidity; 13 of 37 patients had this problem, of which eight had other comorbidities as well. The second and third most common medical comorbidities are gastrointestinal issues and issues affecting the ear, nose and throat. Figure 1 shows the breakdown of medical issues in the cohort.

Baseline characteristics of the standard care and intensive intervention groups are described in Table 2. The one significant difference was the proportion of patients seen as part of multidisciplinary team intervention; all of them were exclusively in the Intensive Intervention group (57.1% vs 0% in standard care,  $p < 0.001$ ).

Figure 2 shows the distribution of medical issues between both standard care and intensive intervention groups. There is a greater variety of medical issues in the group receiving intensive dietetic intervention. The four most common medical issues are gastrointestinal (e.g. reflux, hernia), cardiac (e.g. patent ductus arteriosus, transposition of the great arteries), renal (e.g. chronic kidney disease or end stage renal failure) and Ear, Nose and Throat comorbidities (e.g. tracheo-esophageal fistula, stridor).

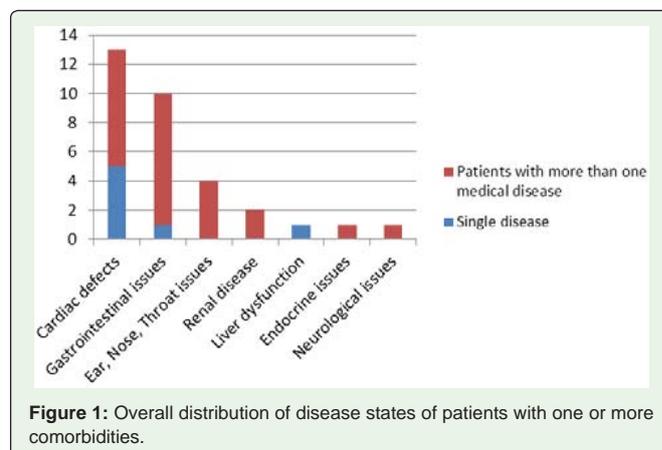
### Primary and Secondary outcomes

The overall mean change in z-scores per month for Weight Velocity (ZΔWV) and Height Velocity (ZΔHV) in the study population are  $0.069 \pm 0.158$  and  $0.031 \pm 0.161$  respectively.

At the initial dietetic visit, 27 of 37 patients had their calorie and protein intakes measured against their requirements. Of these 27 patients, 23 (62.2%) and 12 (32.4%) patients did not meet their calorie and protein requirements respectively.

**Table 1:** Baseline characteristics of study cohort (N = 37).

Characteristics	Study cohort (N = 37)	
Gender	Male	62.20%
	Female	37.80%
Ethnicity	Chinese	62.20%
	Malay	18.90%
	Indian	10.80%
	Others	5.40%
	Missing	2.70%
Housing Type	Public	78.40%
	Private	21.60%
Median age at first visit to the dietitian	8.1 months (range: 0.4-16.8)	
Initial mean weight z-scores at first visit	-2.36±1.16	
Initial mean height z-scores at first visit	-1.59±1.41	
% of population with medical issues	None	49%
	One	22%
	More than one	30%



Only 26 of 37 patients visited the dietitian at least a second time, allowing calorie and protein intakes to be reassessed; of these 26 patients, all of them met the protein requirements, but only 17 (45.9% of the whole cohort) met calorie requirements. All patients had at least two measurements to obtain a weight velocity; 8 of 37 (21.6%) patients did not have a second measurement of height to obtain a height velocity.

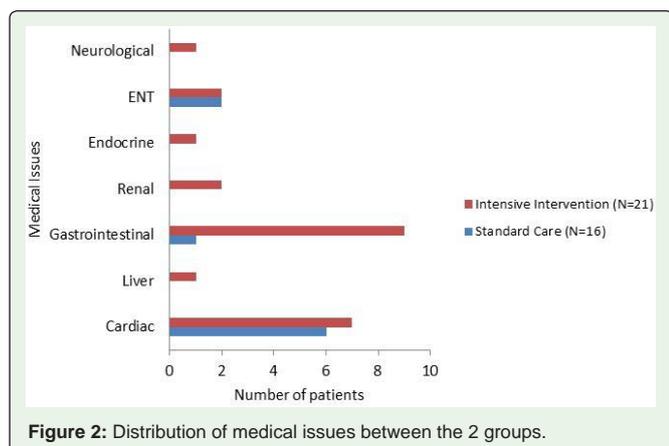
The Backward method of regression proved superior to determine the best predictive model for each of the outcomes of ZΔWV and ZΔHV. Based on this method of regression analysis, the best predictive model for ZΔWV had an R<sup>2</sup> of 0.748 and adjusted R<sup>2</sup> of 0.674. Significant factors associated with better weight gain included multidisciplinary team intervention ( $p < 0.001$ ), staying in public housing ( $p = 0.019$ ), and presence of a medical issue ( $p < 0.001$ ). In the same regression analysis, cardiac ( $p < 0.001$ ), renal ( $p = 0.003$ ) and endocrine ( $p = 0.001$ ) comorbidities were significantly associated with poorer weight velocity.

The best predictive model for ZΔHV had an R<sup>2</sup> of 0.387 and adjusted R<sup>2</sup> of 0.280. Presence of a medical issue ( $p = 0.037$ ) was the main predictor for better height velocity.

**Table 2:** Baseline characteristics of Standard Care versus Intensive Intervention groups.

Characteristics		Standard Care (N=16)	Intensive Intervention (N=21)	P value
<b>Gender</b>	Male	68.80%	57.10%	NA
	Female	31.20%	42.90%	
<b>Ethnicity</b>	Chinese	56.30%	66.70%	NA
	Malay	25%	14.30%	
	Indian	12.50%	9.50%	
	Others	0%	9.50%	
	Missing	6.20%	0%	
<b>Housing Type</b>	Public	93.80%	66.70%	0.104
	Private	6.20%	33.30%	
<b>Average age at first visit (months)</b>		9.76 ± 5.06	6.63 ± 5.11	0.115
<b>Average number of visits to the dietitian</b>		2.13 ± 0.72	5.71 ± 2.39	NA
<b>Number of patients seen as part of the multidisciplinary team</b>		0%	57.10%	<0.001*
<b>% of population with medical issues</b>	None	62.50%	38.10%	0.191
	One or more	37.50%	61.90%	

\*p-values significant at <0.05.



**Figure 2:** Distribution of medical issues between the 2 groups.

Table 3 shows the differences in outcomes between the patients who received intensive intervention against those who received standard care.

Compliance rate in the intensive intervention group was significantly higher (90.8% vs 71.6%, p=0.010) than the standard care group. Average change in z-score weight velocity was also significantly higher (+0.107 vs +0.019, p=0.016) in the intensive intervention group compared to the standard care group.

**Table 3:** Differences in outcomes between standard care and intensive intervention.

Secondary outcomes	Standard Care (N=16)	Intensive Intervention (N=21)	P-value (*significant at p<0.05)
Compliance rate to offered follow ups (%)	71.6 ± 22.0	90.8 ± 12.8	0.010*
Average weight velocity (Δ z-score/month)	0.019 ± 0.099	0.107 ± 0.185	0.016*
Average height velocity (Δ z-score/month)	0.0516 ± 0.1137	0.0094 ± 0.2019	0.451

\*p-values significant at <0.05.

## Discussion

Young children seen by the dietitian over a six-month period had significantly improved weight z-scores, but not height z-scores. This is likely because changes in height tend to lag behind changes in weight, even with intervention, and the study period was too short to demonstrate this improvement. Supporting this is the demonstration that the change per month in weight z-score was over twice that of the height z-score.

Regression analysis identified multidisciplinary team intervention, the presence of medical comorbidities and cardiac issues as the having the strongest associations with changes in weight z-score; the presence of medical comorbidities was also associated with changes in height z-score. Interestingly, the presence of medical comorbidities was associated with better gains in weight as well as height velocity; however, the presence of comorbidities in the cardiac, renal and endocrine systems were all negatively associated with weight gain. There are three possible explanations for this apparent divide. One is the possibility that patients with medical comorbidities had, in general, higher calorie and protein requirements that proved amenable to dietetic intervention whereas those without medical comorbidities had FTT due to financial, care or feeding difficulties; hence the association with better weight velocity in the former. Second, the patients that specifically had cardiac, renal or endocrine comorbidities did worse possibly because their underlying medical conditions were not well-controlled, in addition to requiring extra calories and protein for catch up weight and height gain. Control of

the medical condition is important especially where it is known to affect growth, which is dependent not only on provided nutrition, but also on anabolic hormones, oxygen-carrying capacity and absence of metabolic acidosis, in which any or all of which can be deranged in the above areas. This is exemplified in chronic kidney disease, which leads to multiple physiologic derangements that impair growth: anaemia, metabolic acidosis, hyperparathyroidism and vitamin D deficiency as examples [22,23]. Unfortunately, data on disease control was not available for these patients. Third, the renal and endocrine disorders may not be truly representative of organic failure to thrive resulting from these comorbidities, and thus the results of the linear regression are skewed. Only two patients had renal disease and one patient had endocrine disease. Within each of these categories, there are various possible medical disorders, each with varying degrees of impact on nutrition and growth. Furthermore, even for a specific medical disorder such as chronic kidney disease, the spectrum of severity is dramatic; and thus its impact on growth would be very different between a child with Stage 2 chronic kidney disease versus Stage 5 chronic kidney disease.

Multidisciplinary team review was a significant predictor of improved weight z-scores over time on multiple regression analysis. There is common consensus that the treatment of FTT requires a multidisciplinary approach, which includes the involvement of a nutritionist or paediatric dietitian [24-26]. Multidisciplinary teams with the inclusion of a dietitian have been shown to be effective in improving weight gain in children with low birth weight or faltering growth [27-29]. There was a difference in weight velocity in the subgroup comparison between multidisciplinary team intervention and isolated dietetic input only; this difference was insignificant, which may have been due to small sample size rather than the true absence of a difference. This increase in weight velocity was also similarly reported in Hobbs and Hanks [30].

There are some limitations to this study. As this was a retrospective study with data derived from review of medical records, there were limitations as to the data that was available. This therefore limited the width and depth of the analysis that could be performed, which would have shed more useful information on the outcomes, as growth velocity is multifactorial and this has been shown in the literature. There were four major areas where limited data led to limitations on analysis and interpretation: further information on the sociodemographic background of each patient; information on duration of breastfeeding, the efficiency of feeding and type of feeding difficulty (if present) in each patient would be desirable; information on the exact type, severity, control and complications of comorbid medical conditions where present in each patient. There was no comparison group of children with FTT who did not see a dietitian and continued other routine medical care, and therefore it is not possible to measure the difference when there is dietetic intervention versus none. However, it is neither ethical nor feasible to have such a comparison group for this purpose.

## Conclusion

Dietetic intervention is of benefit, especially in children with medical comorbidities and in low- to middle-income families. However, it is unclear if more frequent dietary supervision confers any added benefit. Multidisciplinary team intervention and control of underlying medical illnesses may provide additional improvement

in growth, but more research on a larger scale is needed in this area. A prospective study with a larger sample size, involving young children with FTT with detailed sociodemographic and medical information should be conducted.

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