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Laporan Kes/Case Report

Optimising Growth Through Early Dietary Intervention in a Prepubertal Boy with Constitutional Delay of Growth and Puberty

Pengoptimuman Pertumbuhan melalui Intervensi Pemakanan Awal dalam kalangan Kanak-kanak Lelaki Pra-Akil Baligh dengan Kelewatan Konstitusi Pertumbuhan dan Akil Baligh

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ABSTRACT

Growth failure in children may result from delayed maturation and long-term inadequate dietary intake. Early nutiritional assessment and appropriate dietary intervention are important to support normal growth and optimise growth potential. A 12-year-9-month-old boy with stunting (< -2 SD) and severe thinness (BMI < -3 SD) was referred to a dietitian for dietary evaluation due to poor growth in weight and height and low body mass index (BMI). He remained prepubertal (Tanner Stage 1) with a bone age of approximately 6 years, consistent with constitutional delay of growth and puberty (CDGP). Dietary assessment revealed chronic undernutrition, with daily energy and calcium intakes meeting only 62% and 36% of requirements, respectively, low calorie density, limited protein variety, and minimal fruit intake. Biochemical investigations were normal for growth hormone and micronutrients. The nutrition diagnosis was inadequate energy intake related to limited food and nutrition-related knowledge regarding appropriate energy intake to support catch-up growth, likely due to lack of prior nutrition education and limited exposure to dietary guidance, leading to inappropriate eating behaviors as evidenced by total energy intake meeting only ~63% of estimated requirements, persistent BMI-for-age < -3 SD (severe thinness), and height-for-age < -2 SD, stunting). A structured intervention was implemented, focusing on calorie-dense meal modification, increased protein variety, calcium-rich foods, and age-appropriate oral nutrition supplementation with family-centred education tailored to vegetarian dietary practices. At two-week follow-up, dietary intake improved, with energy intake reaching 84% of requirements, calcium intake 95%, and protein intake 2.5 g/kg/day. Modest short-term gains in weight (1.24%) and height (0.5 cm) were observed, suggesting a positive early nutritional response. However, the follow-up duration was insufficient to confirm sustained catch-up growth or long-term growth outcomes. Ongoing monitoring every 3 months is required to evaluate growth velocity over time and to determine whether nutritional optimisation can support the child in achieving his genetic height potential.

Keywords: Catch-up Growth, Calcium Intake, Calorie-Dense Diet, Constitutional Delay of Growth and Puberty (CDGP), Oral Nutritional Supplement (ONS)

ABSTRAK

Kegagalan pertumbuhan dalam kalangan kanak-kanak boleh berpunca daripada kelewatan kematangan dan pengambilan diet yang tidak mencukupi dalam tempoh jangka panjang. Penilaian pemakanan awal dan intervensi diet yang sesuai adalah penting untuk menyokong pertumbuhan normal dan mengoptimumkan potensi

pertumbuhan. Seorang kanak-kanak lelaki berumur 12 tahun 9 bulan dengan pertumbuhan terbantut (< -2 SD) dan kurus teruk (BMI < -3 SD) dirujuk kepada ahli dietetik untuk penilaian diet kerana pertumbuhan berat badan dan tinggi yang tidak memuaskan serta indeks jisim tubuh (BMI) yang rendah. Pesakit masih pra-baligh (Tanner Tahap 1) dengan umur tulang sekitar 6 tahun, sejajar dengan kelewatan pertumbuhan dan akil baligh berunsur konstitusional (CDGP). Penilaian diet menunjukkan malpemakanan kronik, dengan pengambilan tenaga dan kalsium harian hanya 62% dan 36% daripada keperluan, kepadatan kalori rendah, variasi protein terhad dan pengambilan buah yang minima. Keputusan ujian biokimia adalah normal untuk hormon pertumbuhan dan mikronutrien. Diagnosis pemakanan ialah pengambilan tenaga tidak mencukupi berkaitan dengan pengetahuan terhad berkaitan pemakanan dan pengambilan tenaga yang sesuai untuk menyokong pertumbuhan pemulihan, berkemungkinan disebabkan oleh kekurangan pendedahan kepada pendidikan pemakanan dan panduan diet, yang membawa kepada corak pemakanan yang tidak sesuai, dibuktikan dengan jumlah pengambilan tenaga hanya memenuhi ~63% daripada keperluan, BMI mengikut umur < -3 SD (kurus teruk) yang berterusan, serta tinggi mengikut umur < -2 SD (pertumbuhan terbantut). Intervensi menumpukan pada pengubahsuaian makanan berkalori tinggi, peningkatan variasi protein, makanan kaya kalsium dan suplemen pemakanan oral sesuai, berserta pendidikan memfokuskan keluarga yang disesuaikan dengan corak diet vegetarian. Temujanji susulan selepas dua minggu menunjukkan pengambilan tenaga meningkat kepada 84%, kalsium 95%, dan protein 2.5 g/kg/hari. Peningkatan sederhana dalam jangka pendek bagi berat badan (1.24%) dan ketinggian (0.5 cm) telah diperhatikan, ini menunjukkan respons pemakanan awal yang positif. Walau bagaimanapun, tempoh temujanji susulan adalah tidak mencukupi untuk mengesahkan berlakunya pertumbuhan pemulihan yang berterusan atau hasil pertumbuhan jangka panjang. Pemantauan berterusan tiga bulan diperlukan untuk menilai kadar pertumbuhan dari masa ke semasa dan menentukan sama ada pengoptimuman pemakanan dapat membantu kanak-kanak tersebut mencapai potensi ketinggian genetiknya.

Kata Kunci: Diet Kalori Tinggi, Pengambilan Kalsium, Pertumbuhan Mengejar, Kelewatan Pertumbuhan dan Akil Baligh Berunsur Konstitusional (CDGP), Suplemen Pemakanan Oral (ONS)

INTRODUCTION

Constitutional Delay of Growth and Puberty (CDGP) is the most common cause of delayed puberty in boys, characterized by short stature relative to age, delayed bone maturation, and slower progression through pubertal stages, while typically resulting in a normal adult height (European Society for Paediatric Endocrinology [ESPE] 2019). Boys with CDGP usually present with delayed testicular enlargement (≥ 4 mL) or absence of Tanner stage G2 characteristics by 13.5-14 years of age (Huynh et al. 2015; Soliman et al. 2022).

Stunting reflects chronic undernutrition, defined as height-for-age < -2 SD (severe < -3 SD), while wasting or thinness reflects acute undernutrition, defined as weight-for-height or BMI-for-age < -2 SD (severe < -3 SD) (Institute for Public Health [IPH], 2019). CDGP patients are typically healthy, with no history of prenatal or perinatal morbidities, chronic illnesses, and eating disorders (Luciano et al., 2025). Although CDGP is generally physiological, when coexists with chronic undernutrition and inadequate dietary intake may exacerbate growth faltering and reduce the likelihood of achieving genetic height potential.

Adequate energy, protein, calcium, and micronutrient intake (particularly vitamin D, iron and zinc) intake during the prepubertal years are critical for supporting linear growth, bone mineralization, and the initiation of pubertal development (National Coordinating Committee on Food and Nutrition [NCCFN] 2017; Soliman et al. 2022). Early identification of nutritional deficiencies in paediatric outpatient settings allows for timely dietetic intervention, supporting catch-up growth and long-term health outcomes (Soliman et al. 2022).

Despite CDGP being a common physiological variant of delayed maturation, evidence specifically guiding nutritional management in this population remains limited. Most clinical literature focuses on endocrine evaluation, growth monitoring, and reassurance rather than structured dietary intervention (Gaudino et al. 2022; Abacı & Besci 2024). Evidence from nutritionally at-risk paediatric populations suggests that oral nutritional supplementation and energy-dense dietary modification can improve weight gain and growth velocity (Alarcón et al. 2003; Huynh et al. 2015). However, these findings are not specific to CDGP, and there is a lack of clinically detailed reports describing individualized dietetic management in this group. This gap limits practical guidance for dietitians managing children who present with both delayed maturation and inadequate dietary intake. Therefore, this case report contributes to the literature by describing structured nutrition care and early growth outcomes in a prepubertal boy with CDGP and faltering growth.

CASE PRESENTATION

A 12-year-9-month-old Chinese boy was referred to the Paediatrics Outpatient Dietetics Clinic due to short stature, poor weight gain, and low BMI. He was diagnosed with constitutional delay of growth

and puberty (CDGP), a temporary condition commonly seen in boys, characterised by delayed bone age (~6 years), delayed sexual maturation (prepubertal, Tanner Stage 1, testicular volume below 4 mL), but with eventual attainment of normal adult height.

He was born full-term via normal vaginal delivery, weighing 3.2 kg (15th-50th percentile), with no feeding difficulties, chronic illness, or developmental delay. Growth had consistently lagged behind peers since age two, but no medical attention was sought until concerns increased upon entering secondary school, prompting referral for nutritional optimisation. Family history supports CDGP which his father experienced a late pubertal growth spurt at 14 years, his mother attained menarche at 14 years, and mid-parental height was 174.6 cm (15th-50th percentile). He attends afternoon school sessions and lives with both parents and one older sister, who had normal growth and menarche.

NUTRITION ASSESSMENT

At the initial assessment, the patient's weight was 24.2 kg and height was 137.5 cm (< -2 SD), indicating stunting, with a BMI of 12.8 kg/m² (< -3 SD), consistent with severe thinness. Over 16 months, height increased from 131.6 to 137.5 cm (~5.9 cm/year), which falls within the lower normal range for a prepubertal boy (5-6.5 cm/year) (Ministry of Health Malaysia, 2019). However, weight gain was only 2.1 kg (~0.13 kg/month), which was below the expected target for catch-up growth (~1.5 kg/month). Achieving this rate would correspond to an approximate 4.7 kg increase to reach a BMI of 15.3 kg/m² at the next three-month follow-up, based on the WHO BMI-for-age growth chart for boys aged 5-19 years. Previous literature indicates that in boys, peak weight velocity occurs at approximately the same time as peak height velocity and averages about 9 kg/year. During catch-up growth, weight gain of approximately two to three times the normal rate has been suggested, although excessive gain should be avoided due to the potential risk of later obesity. Based on this principle, a projected range of 18-27 kg/year (approximately 1.5-2.25 kg/month) was considered (Rogol et al. 2000; American Academy of Pediatrics, 2014). As no specific reference values are available for children with CDGP in this age group, a conservative target of 1.5 kg/month was selected and monitored based on clinical judgement and available growth evidence. Although both height and BMI remain below the median, the upward trends suggest intact growth potential. The patient falls below the mid-parental height target (15th-50th percentile), indicating that his current growth trajectory does not yet reflect his genetic height potential.

Biochemical evaluation demonstrated normal thyroid function with Triiodothyronine (T3: 5.9 pmol/L) and Thyroxine (T4: 17 pmol/L), an adequate cortisol response (831 nmol/L), and an Insulin-like Growth Factor-1 level of 90 ng/mL, which falls within the age-appropriate reference range, indicating preserved growth hormone activity. Serum vitamin D concentration was 64 nmol/L, consistent with sufficiency. No additional micronutrient parameters were assessed, as laboratory investigations were conducted by the attending medical officer as part of the routine medical evaluation. Overall, the available biochemical findings did not indicate endocrine dysfunction or vitamin D deficiency contributing to the patient's growth faltering.

Clinically, the patient appeared alert and cheerful, with normal appetite, adequate sleep (10:30 pm-8:00 am), and regular daily bowel habits (Bristol Stool Form Scale type 3-4). He was independent in activities of daily living, with no oral pain, swallowing difficulties, or gastrointestinal symptoms. Nutrition-focused physical examination (NFPE) revealed no visible loss of subcutaneous fat in the orbital, triceps, or thoracic regions, and no evidence of muscle wasting in the temples, clavicular, shoulder, or interosseous muscle areas. No oedema or other clinical signs of malnutrition were observed. A brief psychosocial screening indicated that the patient was an active participant in school activities and demonstrated age-appropriate social engagement. He did not express concerns regarding body image or self-esteem, and no psychosocial barriers to dietary adherence were identified based on caregiver report and clinical interaction.

Dietary assessment, a 24-hour dietary recall was obtained through self-report to assess the participant's food and nutrient intake. The participant consumed three main meals and two snacks throughout the day, with most meals being home-cooked except for afternoon tea, which was purchased from the school canteen. Breakfast at 8.00 am consisted of two hard-boiled eggs and 200 ml of full-cream packaged milk, providing approximately 260 kcal with 8.6 g carbohydrate, 20 g protein, 15 g fat, and 296 mg calcium. Lunch, consumed between 10.45-11.15 am, included white rice, steamed fish prepared without oil, and stir-fried green leafy vegetables, contributing about 305 kcal, 45 g carbohydrate, 13 g protein, 10 g fat, and 12 mg calcium. Afternoon tea at 3.20-3.40 pm comprised packaged nasi lemak with either half a piece of fried chicken breast or a fried egg, sambal with anchovies, and Teh O with less sugar, supplying approximately 312 kcal, 30 g carbohydrate, 9 g protein, 17 g fat, and 5 mg calcium. Dinner at 7.45 pm consisted of white rice and vegetable soup containing bitter gourd and lentils, contributing around 241 kcal with 45 g carbohydrate, 7 g protein, 2 g fat, and 37 mg

calcium. Supper before bedtime included a fried egg with oil, one slice of wholemeal bread, and one slice of cheese, providing approximately 237 kcal, 19 g carbohydrate, 12 g protein, 13 g fat, and 114 mg calcium. Overall, the total daily energy intake was approximately 1,356 kcal/day (~62% of requirements) and protein 63 g/day (1.8 g/kg, adequate but limited in variety, mainly from eggs). Although protein intake met the requirement, calcium intake remained inadequate at 464 mg/day (~36% of requirements), and fibre intake was low (mainly three servings of leafy green vegetables and only two servings of fruit per month). The patient's father is vegetarian for dinner and weekend meals; however, the patient consumes animal-based protein at other meals. The patient does not have lactose intolerance. The patient is not on any long-term medications and is not taking or prescribed any nutritional supplements.

Physical activity was moderate (~30 minutes/day, including at least 100 jumps, with occasional cycling or badminton on weekends). Both the patient and caregiver demonstrated high readiness to change, and the supportive home environment during family meals and weekends allowed for practical dietary intervention.

Both the patient and patient's mother demonstrated limited understanding of energy requirements and expressed concerns regarding appropriate dietary choices, particularly in selecting foods that support catch-up growth, such as energy-dense meals, protein-rich sources, and calcium-rich foods. This reflects a prior lack of nutrition education and highlights the need for structured guidance. They also have limited knowledge of appropriate portion sizes, feeding frequency, and practical meal planning strategies required to support optimal growth and development.

NUTRITION DIAGNOSIS

Inadequate energy intake related to limited food and nutrition-related knowledge regarding appropriate energy intake to support catch-up growth, likely due to lack of prior nutrition education and limited exposure to dietary guidance, leading to inappropriate eating behaviors [knowledge etiology] as evidenced by total energy intake meeting only ~63% of estimated requirements, persistent BMI-for-age < -3 SD (severe thinness), and height-for-age < -2 SD, stunting).

Malnutrition (undernutrition) related to chronic inadequate energy and protein intake insufficient to support normal growth and development, secondary to constitutional delay of growth and puberty (CDGP) with suboptimal dietary intake [physiologic metabolic etiology], as evidenced by BMI-for-age <−3 SD (severe thinness), height-for-age < −2 SD (stunting), total energy intake meeting only ~63% of estimated requirements, and failure to achieve expected catch-up growth.

NUTRITION GOAL

The short-term goals (1-2 weeks) were to increase the patient's daily energy intake to meet at least 80-90% of requirements, improve calcium intake to approach recommended levels, and introduce greater protein variety to support early catch-up growth.

Long-term goals (3-6 months) focused on achieving consistent weight and height gain towards the expected catch-up trajectory, and establishing lasting family-centered eating habits that support healthy growth, alongside regular physical activity and adequate sleep to enhance overall development.

NUTRITION INTERVENTION

By comparing with several comparative standards, such as the Recommended Nutrient Intake (RNI, 2017), the Failure to Thrive (FTT) formula (Peterson & Washington, 1984), and the Schofield formula for boys aged 10-18 years (Schofield, 1985), with the dosing weight targeted at the 3rd to 50th percentiles (28-34 kg), the patient's nutrition prescription was set at 2,200 kcal/day to support catch-up growth. The protein target was set at 1.8-2.5 g/kg/day, which falls within ranges shown to support muscle and bone accretion. Although higher intakes of up to 2.8 g/kg/day have been reported in specific research settings (Mukhlas Fikri et al. 2024), such levels should be approached with caution. Protein intake above the upper target should only be considered on an individual basis with close monitoring of renal function, hydration status, and overall energy balance, particularly in growing individuals or those with underlying health conditions. Therefore, the recommended intake for this case prioritised a moderate, evidence-based range to optimise benefits while minimising potential risks associated with excessive protein consumption. Calcium intake was prescribed at 1,300 mg/day (RNI 2017), achieved through dietary sources and oral nutrition supplementation.

The nutrition intervention focused on optimising the patient's dietary intake to support catch-up growth and was delivered using a family-centred approach. The patient and caregiver were first educated on the importance of dietary modification and appropriate portion sizes, emphasizing that inadequate energy intake was the main contributor to the patient's persistent thinness and limited growth despite intact genetic potential. The rationale for increasing calorie density was clearly explained, highlighting that a growing prepubertal child requires sufficient energy not only for daily activities but also for tissue building, immune function, and bone development. In addition to

energy, the importance of adequate and varied protein sources was emphasised, as protein is essential for muscle accretion, bone matrix formation, and recovery from chronic undernutrition. Calcium was highlighted as a critical nutrient for bone mineralisation and linear growth, particularly in a child with delayed bone age.

A detailed menu plan was developed for the family, incorporating interchangeable options from each macronutrient group to support flexible meal construction. Simple, practical plant-based recipes aligned with the father's vegetarian pattern were also developed to help the family enrich meals with energy, protein, and micronutrients using affordable, easy-to-prepare ingredients such as tofu, *tempeh*, eggs, legumes, and soymilk alternatives. Education emphasised practical strategies that aligned with household eating practices and planning balanced school meals.

A stepwise dietary plan was introduced to address specific nutrient inadequacies. First, calorie-dense ingredients were incorporated through the use of healthy fats such as olive oil, canola oil, sesame oil, nuts, seeds, avocado, and nut spreads. These options were demonstrated in the context of the family's usual meals, such as adding one to two teaspoons of oil to steamed fish, stir-fried vegetables, and soups, or including peanut butter or avocado on bread to increase caloric intake without excessive food volume. Second, protein variety was expanded to improve overall nutrient quality and support muscle and bone accretion. Both animal-based and plant-based protein sources were discussed, including eggs, poultry, fish, tofu, tempeh, lentils, red beans, and baked beans. Considering the father's vegetarian diet and the family's shared evening meals, cooking methods that blend plant-based proteins into dinner dishes were taught to promote practicality and sustainability, such as adding tofu into soups, incorporating tempeh into stir-fries, or preparing lentil-based dishes.

Third, despite adequate protein intake, calcium intake remained low. Therefore, calcium intake was prioritised due to the patient's markedly low baseline intake and the critical role of calcium in bone mineralisation, particularly in prepubertal children with delayed growth. The caregiver was educated on both dairy and non-dairy calcium sources, including milk, cheese, yoghurt, fortified soy milk, tofu, *tempeh*, sardines, and leafy green vegetables such as *kailan* and *sawi*. Practical strategies for increasing calcium intake included adding cheese to sandwiches, spreading baked beans on bread, and offering yoghurt with almonds as snacks.

To further support nutrient adequacy, the patient was prescribed an age-appropriate oral nutritional supplement (Pediasure 10+®) due to its higher calcium content. Two servings per day (5 scoops + 190 mL lukewarm water) were recommended, providing an additional ~454 kcal, 17 g protein, and 900 mg calcium daily. The supplement was scheduled for the morning and pre-bedtime to prevent any reduction in appetite during main meals. Research indicates that with approximately 2 servings/day of PediaSure (or similar oral nutritional supplements), improvements in weight are typically observed within 4-8 weeks, whereas measurable height/linear growth usually becomes apparent after 4-8 months of continuous use (Alarcon et al. 2003).

Education was also provided on increasing fibre intake through daily consumption of fruits (2 servings) and vegetables (3 servings), recognising their contribution to micronutrient intake, bowel regularity, and vitamin C content, which enhances iron absorption. Lifestyle modifications were reinforced, including maintaining 9-11 hours of sleep per night to support growth hormone secretion and engaging in regular physical activity such as skipping, badminton, or cycling at least 3-5 times per week to stimulate appetite, strengthen muscles, and promote healthy growth. A family-centred behavioural counselling approach underpinned the intervention. This included addressing barriers related to family meal patterns, supporting meal planning within the context of the father's vegetarian practices, encouraging consistent food preparation methods at home, and strengthening caregiver confidence in managing the child's dietary needs. Through collaborative goal-setting and continuous caregiver engagement, the intervention aimed to improve dietary compliance and ensure long-term sustainability of healthy eating habits to optimise the child's growth trajectory.

NUTRITION MONITORING AND EVALUATION

A two-week outpatient follow-up was conducted via phone call to assess anthropometric progress, dietary intake, oral nutrition supplement (ONS) acceptance, and adherence to the prescribed intervention. Early dietary improvements were observed. The patient's body weight increased by 0.3 kg and height by 0.5 cm. Although his BMI improved to 12.9 kg/m², it remained below -3 SD, indicating persistent severe thinness but some early improvement in nutritional status. Weight gain was below the targeted velocity, whereas height increase was consistent with expected interval growth. However, the short follow-up period limits the ability to draw conclusions regarding linear growth. Additionally, reliance on home measurements may reduce the validity of the data due to variations in measurement equipment, location, and personnel.

It is also important to note that anthropometric measurements obtained during home-based follow-

up may vary from hospital-based measurements due to differences in equipment, measurement technique, and potential technical error; therefore, a longer follow-up duration (e.g., 3 months) is recommended to more accurately evaluate true growth trends and intervention effectiveness.
In addition, biochemical parameters will require ongoing monitoring, particularly the renal profile, given the relatively high protein provision; this will be reassessed during the 3-month follow-up at the dietetics clinic to ensure metabolic tolerance and safety.

Dietary evaluation using a three-day food diary showed notable improvements in intake quality and quantity. The patient consumed PediaSure® 10+ twice daily as recommended, contributing approximately 24% of daily energy and 73% of total calcium intake. He tolerated the supplement well, reporting no gastrointestinal discomfort, and both the patient and caregiver demonstrated excellent compliance. Total energy intake increased from 1,356 kcal to 1,855 kcal/day (~84% of estimated requirements). Calcium intake improved markedly from 464 mg to 1,238 mg/day (~95% of requirements). Protein intake reached 2.5 g/kg/day with greater diversity of sources. Fruit consumption increased from twice per month to twice per week, indicating better dietary variety.

Physical activity patterns remained appropriate for his age, consisting of daily jumping activities (~30 minutes) and intermittent participation in badminton or football during weekends. The caregiver reported an enhanced understanding of nutrition goals, reflecting improved family engagement and adherence to recommended practices. Overall, the nutrition diagnosis of inadequate energy intake remains active and in progress. The patient has shown meaningful early improvements across anthropometric, dietary, and behavioural domains. Continued monitoring is required to ensure sustained catch-up growth and achievement of targeted nutritional goals. The next follow-up visit is scheduled in three months in the dietetics clinic.

DISCUSSION

This case highlights the interaction between CDGP and chronic undernutrition, demonstrating how inadequate dietary intake can further compromise growth outcomes in an otherwise physiological growth variant. Although CDGP is typically characterised by delayed skeletal maturation and pubertal onset with eventual attainment of normal adult height, suboptimal nutritional status may exacerbate growth faltering and delay the realisation of genetic height potential (Rogol et al. 2000; Soliman et al. 2022). The patient presented with persistent severe thinness and stunting despite normal endocrine function, a pattern consistent with previous observations that energy insufficiency primarily limits weight gain and may secondarily impair linear growth in prepubertal children (Rogol et al. 2000).

Although CDGP is generally considered a self-limiting condition, short-term low-dose testosterone therapy may be considered in selected boys when delayed puberty is associated with significant psychological distress. However, pharmacological intervention is not routinely required in CDGP, as most boys will enter puberty spontaneously and achieve normal adult height without hormonal treatment (Gaudino et al. 2022). Importantly, testosterone therapy does not replace the need for adequate nutritional support. Nutritional inadequacy may independently limit growth response and compromise the effectiveness of spontaneous or induced pubertal growth. Therefore, optimisation of dietary intake remains a fundamental component of management, particularly in children with co-existing undernutrition, regardless of whether hormonal therapy is considered (Gaudino et al. 2022; Soliman et al. 2022).

Catch-up growth is recognised to be nutritionally demanding, requiring sufficient energy availability alongside increased protein intake to support tissue accretion (American Academy of Pediatrics 2014; Fikri et al. 2024). Recent reviews propose protein intakes ranging from 2.0 to 3.0 g/kg/day for nutritionally compromised children, while cautioning against prolonged excessive intakes due to potential metabolic consequences (Fikri et al. 2024). In this case, the achieved protein intake of approximately 2.5 g/kg/day aligns with these recommendations, providing anabolic support without exceeding suggested upper limits. Notably, the increase in protein intake occurred largely as a consequence of improving calcium adequacy, as several calcium-rich foods and oral nutritional supplements also contributed substantial protein. This highlights the interdependence of nutrient optimisation in clinical practice, where targeting one limiting nutrient may concurrently influence others. Nevertheless, given the relatively high protein provision, ongoing monitoring of renal function is warranted to ensure metabolic tolerance and safety during sustained nutritional rehabilitation.

Calcium inadequacy was another key contributor to growth risk in this patient, given calcium's essential role in bone mineralisation and linear growth, especially in children with delayed bone age (NCCFN 2017; Soliman et al. 2022). The marked improvement in calcium intake following dietary modification and oral nutritional supplementation reflects findings from previous intervention studies showing that supplementation can effectively address micronutrient gaps when dietary sources alone are insufficient (Alarcón et al. 2003; Huynh et al. 2015). However, supplementation was

implemented as an adjunct rather than a replacement for meals, supporting sustained dietary behaviour change and appetite preservation.

The modest increases in weight and height observed after two weeks should be interpreted cautiously. Short-term anthropometric changes may reflect early nutritional responsiveness rather than definitive catch-up growth, which typically requires several months of sustained intervention. Additionally, home-based anthropometric measurements are subject to technical variability, further limiting short-term interpretation.

Nonetheless, the rapid improvement in dietary adequacy, adherence to oral nutritional supplementation, and caregiver engagement are clinically meaningful indicators that the patient is progressing towards a favorable growth trajectory. Family meal patterns significantly influenced dietary intake in this case. The father's vegetarian diet during dinner and weekend limited available animal-protein sources, necessitating a family-centered approach to ensure adequate nutrient provision. Strategies included incorporating a variety of plant-based proteins (tofu, lentils, *tempeh*), emphasizing higher-calorie and animal-protein sources earlier in the day, and ensuring the inclusion of micronutrient-rich foods such as fruits and vegetables. Practical interventions such as adding healthy oils to cooked meals and modifying school meals were also effective in addressing nutritional gaps.

This case reinforces the importance of individualized, structured, evidence-based, and family-centred dietetic intervention in children with CDGP and faltering growth. While nutritional therapy cannot alter the intrinsic timing of pubertal onset, it plays a critical role in ensuring that children enter puberty with sufficient nutritional reserves to support optimal pubertal growth and bone accretion (Rogol et al. 2000; Soliman et al. 2022). Tailoring dietary strategies to household eating patterns, particularly in families practising partial vegetarianism, enhances feasibility, adherence, and long-term sustainability. Overall, this report contributes practical clinical insight into the role of nutrition optimisation as a cornerstone of supportive management in CDGP complicated by chronic undernutrition.

CONCLUSION

In conclusion, this case highlights the importance of early nutritional optimisation in a prepubertal boy with constitutional delay of growth and puberty (CDGP) and chronic undernutrition. Comprehensive dietetic intervention led to improvements in dietary adequacy, including increased energy and calcium intake and greater variety of protein sources, within a short follow-up period. While substantial linear growth cannot be conclusively assessed over two weeks, the initial dietary response suggests improved nutritional support for growth and bone accretion. With continued family involvement, sustained dietary intervention, and regular long-term outpatient monitoring, nutrition support has the potential to facilitate catch-up growth and optimise growth outcomes, enabling children with CDGP to approach their full height potential over time.

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CONFLICT

The authors declare no conflict of interest.

REFERENCES

Abacı, A. & Beşci, Ö. 2024. A current perspective on delayed puberty and its management. *Journal of Clinical Research in Pediatric Endocrinology* 16(4): 379-400. https://doi.org/10.4274/jcrpe.galenos.2024.2024-2-7

Alarcón, P.A., Lin, L.-H., Noche, M., et al. 2003. Effect of oral supplementation on catch-up growth in picky eaters. *Clinical Pediatrics* 42(3): 209-217. https://doi.org/10.1177/000992280304200304

American Academy of Pediatrics. 2014. Failure to thrive. In: *Pediatric nutrition: Policy of the American Academy of Pediatrics*. 7th ed. Elk Grove Village, Illinois: American Academy of Pediatrics. pp. 663-700.

European Society for Paediatric Endocrinology (ESPE). 2019. Constitutional delay of growth and puberty. *Hormone Disorders Series*. European Society for Paediatric Endocrinology.

Gaudino, R., De Filippo, G., Bozzola, E., Gasparri, M., Bozzola, M., Villani, A. & Radetti, G. 2022. Current clinical management of constitutional delay of growth and puberty. *Italian Journal of Pediatrics* 48(1): 45. https://doi.org/10.1186/s13052-022- 01223-7

Fikri, A.M., Astuti, W., Nurhidayati, V.A., Prameswari, F.S.P. & Ismail, N.H. 2024.

Protein intake recommendation for stunted children: An update review. *Nutrición Clínica y Dietética Hospitalaria* 44(3): 117-123. https://doi.org/10.12873/443mukhlas

Huynh, D.T.T., Estorninos, E., Capeding, R.Z., Oliver, J.S., Low, Y.L. & Rosales, F.J. 2015. Longitudinal growth and health outcomes in nutritionally at-risk children who received long-term nutritional intervention. *Journal of Human Nutrition and Dietetics* 28(6): 623-635. https://doi.org/10.1111/jhn.12306

Institute for Public Health (IPH). 2019. Possible risk factors for malnourished children aged below five years in Putrajaya, 2018. Institute for Public Health, Ministry of Health Malaysia.

Luciano, T.M., Stecchini, M.F. & Antonini, S.R.R. 2025. Boys with constitutional delay of growth and puberty developed spontaneous puberty and reached standard adult height without pharmacological therapy. Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo.

Ministry of Health Malaysia. 2019. Paediatric protocols for Malaysian hospitals. 4th ed. Ministry of Health Malaysia.

Mukhlas Fikri, A., Astuti, W., Nurhidayati, V.A., Prameswari, F.S.P. & Ismail, N.H. 2024. Protein intake recommendation for stunted children: An update review. *Nutrición Clínica y Dietética Hospitalaria* 44(3): 117-123. https://doi.org/10.12873/443mukhlas

National Coordinating Committee on Food and Nutrition (NCCFN). 2017. Recommended nutrient intakes for Malaysia: A report of the Technical Working Group on Nutritional Guidelines. Ministry of Health Malaysia.

Rogol, A.D., Clark, P.A. & Roemmich, J.N. 2000. Growth and pubertal development in children and adolescents: Effects of diet and physical activity. *The American Journal of Clinical Nutrition* 72(2): 521S-528S.https://doi.org/10.1093/ajcn/72.2.521S

Soliman, A.T., Alaaraj, N., Noor Hamed, Alyafei, F., Ahmed, S., Shaat, M., Itani, M., Elalaily, R. & Soliman, N. 2022. Nutritional interventions during adolescence and their possible effects. *Acta Bio-Medica: Atenei Parmensis* 93(1): e2022087. https://doi.org/10.23750/abm.v93i1.12789