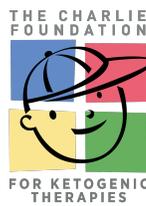


## KETOGENIC DIET FOR PRADER-WILLI SYNDROME



A REVIEW OF THE TREND COMMUNITY  
PWS DIET INITIATIVE

## OVERVIEW

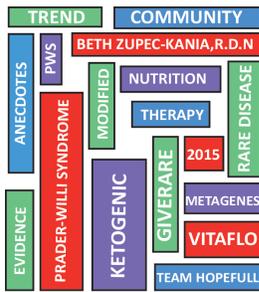
In August 2015, Trend Community\* launched the *PWS Diet Initiative* to explore the effectiveness and benefits of nutrition therapy for Prader-Willi Syndrome (PWS). Ten children ages 2-11 with a genetic diagnosis of Prader-Willi Syndrome undertook a modified ketogenic diet (MKD) under the guidance and supervision of consultant nutritionist to the Charlie Foundation for Ketogenic Therapies, Beth Zupec-Kania, RDN. Participants journaled about their experience and contributed anecdotal observations and patient-reported data through TREND Community.

## DIET INITIATIVE GOALS

Due to a genetic predisposition to very rapid weight gain leading to obesity, individuals with PWS must strictly regulate diet from a young age. *The Red Yellow Green System for Weight Management*, widely prescribed by medical professionals to help individuals with PWS attain weight loss goals, restricts the intake of high-calorie, high-fat foods. In contrast, Miller (1) found that children who followed a diet consisting of 30% fat, 45% carbohydrates and 25% protein, with at least 20 grams of fiber per day, experienced improvements in weight control and body composition compared to the children placed on low-fat, energy-restricted diets (2). Anecdotal reports from families in the PWS community suggest that boosting dietary fat to elicit ketones, along with a diet comprised of mostly plant-based carbohydrates and moderate protein, may provide even more benefit to individuals with PWS. The PWS Diet Initiative was designed to: explore the requests from these families, identify ideal macronutrient intake and open the door to research on this topic. The Diet Initiative was carefully structured to uncover the diet-related problems that occur with PWS.

### Exploring Benefits

The first task was to determine if a structured, modified ketogenic therapy provided benefit to children with PWS in the areas of hunger, cognition, behavior, energy, body composition, and quality of life. A structured diet was chosen in an attempt to eliminate the guesswork in estimating portions of food and to make the diet more objective for the purpose of evaluating benefit. A modified ketogenic diet was selected as opposed to the much more restrictive classic ketogenic diet to allow more variety, larger portions and to eliminate the risk of excessive ketosis.



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### **Exploring Practicality**

The second task was to determine if families could incorporate this diet into their daily lives. Whereas restrictive diets are difficult for most people to adhere to, ketogenic diet therapies administered to children with epilepsy by their caregivers have an unusually high compliance rate due to the positive outcome achieved by the majority who attempt it (2). Thus it was determined by the nutritionist that this could be a successful diet for the PWS community.

### **DIET INITIATIVE SUMMARY**

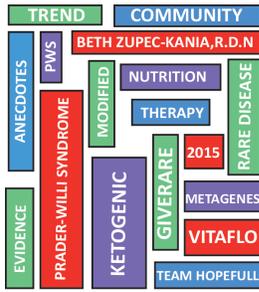
Of the 108 families who signed up, 14 ultimately qualified to participate and 10 completed the full 6 months of managing this diet for their child. The Diet Initiative utilized a gradual transition to the modified ketogenic therapy, which allowed families several weeks to change from their child's current diet to the structured ketogenic meal plans. Diets were individually prescribed to meet Dietary Reference Intakes (DRI) for Energy with an average of 75% fat, 14% protein and 11% carbohydrate. In addition to the diet, nutritional supplementation was advised by the nutritionist to meet DRI. Support was provided through conference calls and [ketodietcalculator.org](http://ketodietcalculator.org) (a web-based diet calculator).

A typical day's menu included a breakfast of high-fat yogurt with berries and heavy cream; sliced turkey rolled up in spinach leaves with mayonnaise and mustard for lunch; spaghetti squash with beef marinara sauce and olive oil for dinner. Snacks included nuts or berries with heavy cream. Participants also received a special form of coconut oil (called medium chain triglycerides) with their meals.

All participants were required to inform primary doctors about their participation in the Diet Initiative and obtain surveillance blood work at initiation, 3 months and 6 months. Caregivers completed data tracking of glucose, ketones, labs and outcome measures through TREND Community. Negative effects of the diet were minimal and constipation was not present in any participant. The *PWS Diet Initiative Case Series* details the experience of each participant.

### **Reported Benefits**

Journal entries from families reveal that the modified ketogenic diet (MKD) was beneficial to their children; all experienced positive benefits in at least 2 areas (Table 1).



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**Table 1. Reports of positive benefits of a modified ketogenic diet on children as reported by caregivers in the PWS Diet Initiative**

Initiative ID	Age**	Hunger/satiety	Cognition/developmental	Behavior	Energy	Body Composition	Quality of Life
Keto-1	4y 11m	X	x	x	X	x	X
Keto-2	4 y 1m	X	x	x	X		X
Keto-4	7y 1m	X	x	x	X		X
Keto-6	2y 9m		x	x	X	x	X
Keto-8	3y 4m	X	x	x	X	x	X
Keto-9	4y 1m	X	x				X
Keto-10	4y 11m	X					X
Keto-12	5y 10m	X	x	x	X	x	X
Keto-14	6y 6m	X	x	x	X		X
Keto-15	11y 11m	X			X		X

\*\*Indicates participant's age at the end of the Diet Initiative.

*"For the first time in her life she is satiated."* (keto-12)

*"[Her] communication skills have exploded in the past months."* (keto-8)

*"[Her] behaviors have changed for the better."* (keto-3)

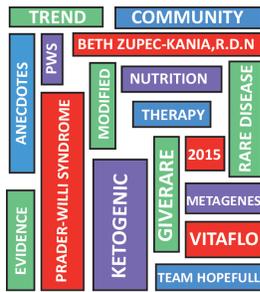
*"[His] energy level is through the roof...he is able to keep up with his peers."* (keto-6)

*"[She] has for the first time in her life maintained weight whilst still growing."* (keto-12)

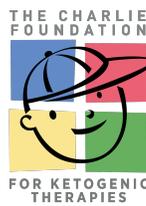
*"Today felt like what it must be like to be a "normal" family."* (keto-4)

## **Diet Adherence**

Despite the reported burden of meal preparation and more frequent grocery shopping, once families adopted the diet they were likely to continue. Although the Diet Initiative was designed for 6 months, all ten families who completed 6 months have continued well beyond that time. The four families who did not complete 6 months withdrew due to reasons other than effectiveness; two never attempted the diet (one did not start due to health issues and the other decided they did not have the necessary time to commit to the Diet Initiative) and two



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attempted the diet for a short period of time, but found meal preparation and data tracking to be burdensome and unmanageable for their families.

*“Food prep is the most difficult part for us.” (keto-4)*

*“It’s hard to feed one child one thing and another child something completely different.” (keto-14)*

### **Negative Effects**

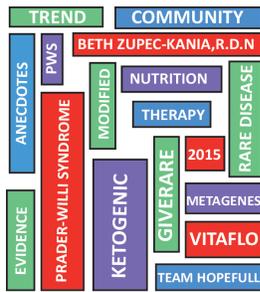
Two of the 10 children who completed 6 months of the diet initially experienced acidosis, which was resolved with treatment using supplements. Two of the ten children had persistent elevated cholesterol even prior to the Diet Initiative; both have a familial history and the PWS genetic subtype (UPD), which increases the risk of having high cholesterol. Diet modifications and supplements were included to assist in lowering cholesterol in both children; lab work from one of the children confirmed that cholesterol levels lowered within six months. None of the ten children experienced constipation, a common adverse-effect of the classic ketogenic diet.

### **PRELIMINARY FINDINGS**

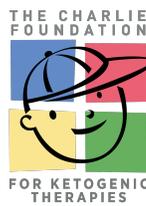
This exploration discovered that a structured, modified ketogenic diet following the recommended dietary allowance for calories and protein intake has positive effects on children with PWS. A clinical trial would be necessary to confirm these findings. In light of the neuro-protective effects that ketogenic diets have on people with epilepsy, we are hopeful that some of the long-term effects of PWS may also be ameliorated or prevented such as obesity, behavior disorders and cognitive issues.

### **GOALS FOR THE NEXT EXPLORATION**

To increase the participation retention rate to 100% participants may start on a more liberal, less structured diet. After at least 6 weeks on this plan, we will offer the option to graduate to the structured, modified ketogenic diet (used during the first Exploration). The structured diet may provide more benefit for some. Given reports of improved body composition during the first Diet Initiative (documented with before and after pictures), PWS Diet Initiative II will also aim to explore the potential for high fat/low carbohydrate diets for weight maintenance and weight loss for individuals with PWS.



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### ABOUT THE TREND COMMUNITY PWS DIET INITIATIVE

\*TREND Community is an invitation-only network of consented patients and caregivers living with rare disease who are sharing stories & patient-reported data using leading-edge, clinical-trial quality tools. The collected data may allow health care clinicians, scientists and researchers to generate their own hypotheses that could be used to inform or form the foundation of future research.

TREND does not provide medical advice, nor does it promote specific therapies, diets, or treatments. The results derived from this Diet Initiative should not be generalized to the larger Prader-Willi Syndrome population and are only meant to provide insights and points of reference to the individual participants.

### REFERENCES

1. Miller JL, Lynn CH, Shuster J & Driscoll DJ. *A reduced-energy intake, well-balanced diet improves weight control in children with Prader-Willi syndrome*, J Hum Nutr Diet (2012), 26(1): 2-9.
2. Lee PR, Kossoff EH. *Dietary treatments for epilepsy: Management guidelines for the general practitioner*, Epilepsy Behav (2011), doi:10.1016.

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