

# The Effects of Gluten-Free Diet on Body Weight in Children with Celiac Disease

Marko Lukić<sup>1</sup>, Ana Šegec<sup>2</sup>, Igor Šegec<sup>3</sup>, Ljerka Pinotić<sup>4</sup>, Jasminka Milas Ahić<sup>5</sup>, Rudika Gmajnić<sup>6</sup>, Krešimir Pinotić<sup>7</sup> and Aleksandar Včev<sup>5</sup>

<sup>1</sup> Department of Nutrition, University Hospital Center Osijek, Osijek, Croatia

<sup>2</sup> Department of Pathologic Anatomy and Forensic Medicine, University Hospital Center Osijek, Osijek, Croatia

<sup>3</sup> Department of Otorhinolaryngology and Maxillofacial Surgery, University Hospital Center Osijek, Osijek, Croatia

<sup>4</sup> Department of Pediatrics, University Hospital Center Osijek, Osijek, Croatia

<sup>5</sup> Clinic for Internal Medicine, University Hospital Center Osijek, Osijek, Croatia

<sup>6</sup> School of Medicine, University »J. J. Strossmayer«, Osijek, Croatia

<sup>7</sup> Clinic for Surgery, University Hospital Center Osijek, Osijek, Croatia

## ABSTRACT

*This study was aimed at monitoring and controlling of body weight in children with diagnosis of celiac disease when established and after introducing gluten-free diet. Prospective clinical study included 42 children with celiac disease whose body weight was measured before introducing gluten-free diet, and after the period of six and 18 months of introducing gluten-free diet. The children were divided into three age groups. The first group consisted of 16 children, 8 females and 8 males in the age from 6 to 18 months, the second group consisted of 14 children, 8 females and 6 males ranging from the age of 20 to 111 months and the third group consisted of 12 children, 6 females and 6 males ranging from the age of 115 to 204 months. The measured body weight was compared with the centile tables of children of the same age. After introducing gluten-free diet the body weight was significantly higher at first, especially at the second control examination in comparison to the centile table of children of the same age and gender. When comparing the results at the time of establishing the diagnosis and at the first and second control examination of the body weight of children the results showed no difference concerning gender and the age of children. In conclusion it can be said that is very important to diagnose celiac disease as soon as possible because the introduction of gluten-free diet prevents the pathological conditions mucosal lesion of small intestine and the physical retardation of children.*

**Key words:** celiac disease, children, gluten free diet, body weight, centile, gluten enteropathy

## Introduction

Celiac disease or gluten enteropathy is chronic autoimmune disease of gastrointestinal system in genetic predisposed individuals. It is usually recognized and diagnosed in infants between 6<sup>th</sup> and 18<sup>th</sup> months when the mixed food containing mostly wheat and cereals is added to the breastfeeding. Very often the gluten enteropathy is not diagnosed in early childhood, since this period of detection can be prolonged to 18 years and even in elderly age<sup>1–4</sup>.

The disease is caused by a permanent intolerance to gliadin fraction of gluten found in wheat, rye, barley, and oat<sup>5</sup>. This protein leads to immunobased reaction which

results in atrophic mucosal lesion of jejunum and permanent gluten intolerance<sup>6</sup>.

The clinical examination of children and adolescents<sup>7</sup> shows gastrointestinal but also extra intestinal symptoms like dermatitis herpetiformis, defect of teeth enamel, osteoporosis, growth retardation<sup>8</sup>, delayed puberty, persistent sideropenic anemia<sup>9</sup>.

The disease is functionally characterized by severe intestinal malabsorption with histological lesion of mucosa in the upper part of small intestine. The lesions are provoked by food which contains gluten<sup>10</sup>. In clinical mani-

festation dominate chronic diarrhea, abdominal cramps, bloating, fatigue, headache and even constipation<sup>2</sup>. The characteristic features are: asthenic constitution, skinny limbs with big bowel<sup>11</sup>. The children with celiac disease who do not follow the gluten-free diet develop the delay of the mineralization and maturation of bones<sup>9,16</sup>. The studies show that the celiac patients have higher risk for getting cancer, especially B and T cell lymphoma, but lower risk for getting breast and lung cancer as well as heart attack<sup>12</sup>. The results of other studies show that a strict gluten-free diet protects from development of enteropathy associated with T-cell lymphoma<sup>13</sup>. The lesion of the liver and dysfunction (cryptogenic and autoimmune)<sup>14</sup> can often be found in celiac patients.

The diagnosis was established with blood test of specific antibodies: gliadin, endomysial, tTG (tissue transglutaminase). After positive tests it is necessary to provide mucosal biopsy by suction capsule or endoscopically, and the pathohistological data confirm the diagnosis of celiac disease. The elimination of gluten from food leads to the remission of the disease and the repair of the mucosa of small intestine<sup>15</sup>.

Clinical, functional and pathoanatomical signs disappear rapidly if gluten – alpha gliadin the ingredients of wheat, rye, barley and oats is eliminated from food. The gluten-free diet does not mean only avoiding the products like bread, noodles, cakes, fried food etc. because gluten can be present in the processed products, so that the products must be controlled<sup>17–21</sup>.

## Subjects and Methods

In this prospective study 42 children were included (20 boys and 22 girls) ranging from the age of 6 months to 17 years. The patients were sent to outpatient office at the Department of Pediatrics of University Hospital Center Osijek because of failure to thrive or doubt of malabsorption. At the first examination the case history was taken, the body weight was measured as well as the physical status<sup>22,23</sup>.

Based on medical records and clinical signs the blood samples were collected for total serum gliadin antibodies, endomysial antibodies and tTG class IgA and IgG (ELISA method).

After positive data AGA, EMA, tTG and positive biopsy with atrophy of intestinal villi of small intestine and higher presence of intraepithelial lymphocytes the diag-

nosis of celiac disease was confirmed and the gluten-free diet was introduced. The patients were invited to the first control checkup in six months.

After six months at first control checkup the body weight was controlled. The gluten-free diet was continued and in a year they have been invited to the second control checkup<sup>25</sup>.

At the second control checkup one and half year after introducing gluten-free diet they were measured weight again. The patients were at the gluten-free diet the whole time.

The children were divided into three age groups for the statistical evaluation. The first group consisted of 16 children, 8 females and 8 males in the age from 6 to 18 months, the second group consisted of 14 children, 8 females and 6 males ranging from the age of 20 to 111 months and the third group consisted of 12 children, 6 females and 6 males ranging from the age of 115 to 204 months.

## Statistical Analysis

The basic statistics were used for statistical analysis. Friedman test and Mann Whitney U test were already used for testing differences of statistical significances. Statistical significance is considered as the difference confirmed at the level  $p < 0.05$ . The data were graphically presented by Box and Whisker Plot diagram. The statistical boxes SPSS 16.0 and Statistics 6.0 were used in statistical analysis.

## Results

In children with established diagnosis of celiac disease we followed the body weight with the recommendation to be on the gluten-free diet. For children with celiac disease it is very important to gain weight, to grow and to develop. A big amount of food can be ingested but without weight gaining.

Centile values of body weight of children with celiac disease for first group (age of 6 to 18 months) are showed in Table 1. The results show that 50% of children at the time the celiac disease was diagnosed had body weight under 7.5<sup>th</sup> centile. At the first control checkup after six months and 6 months of gluten-free diet 50% of children reached the 25.0<sup>th</sup> centile and moreover at the second

**TABLE 1**  
BODY WEIGHT OF THE FIRST GROUP OF CHILDREN WITH CELIAC DISEASE DURING THREE CHECKUPS EXPRESSED BY CENTILE AND IN KILOGRAMS

	BW-Dg Centile	BW-Dg (kg)	BW-C <sub>1</sub> Centile	BW-C <sub>1</sub> (kg)	BW-C <sub>2</sub> Centile	BW-C <sub>2</sub> (kg)
Median	7.5	8.15	25.0	10.10	50.0	12.70
Lower quartile	5.0	7.45	5.0	9.60	25.0	12.00
Upper quartile	17.5	9.65	50.0	11.00	50.0	13.20
Qvartile range	12.5	2.20	45.0	1.40	25.0	1.20

**TABLE 2**  
BODY WEIGHT OF THE SECOND GROUP OF CHILDREN WITH CELIAC DISEASE DURING THREE CHECKUPS EXPRESSED BY CENTILE AND IN KILOGRAMS

	BW-Dg Centile	BW-Dg (kg)	BW-C <sub>1</sub> Centile	BW-C <sub>1</sub> (kg)	BW-C <sub>2</sub> Centile	BW-C <sub>2</sub> (kg)
Median	15.0	17.00	25.0	18.35	50.0	22.00
Lower quartile	5.0	11.50	5.0	13.50	25.0	15.00
Upper quartile	50.0	19.50	50.0	21.20	50.0	26.00
Qvartile range	45.0	8.00	45.0	7.70	25.0	11.00

**TABLE 3**  
BODY WEIGHT OF THE THIRD GROUP OF CHILDREN WITH CELIAC DISEASE DURING THREE CHECKUPS EXPRESSED BY CENTILE AND IN KILOGRAMS

	BW-Dg Centile	BW-Dg (kg)	BW-C <sub>1</sub> Centile	BW-C <sub>1</sub> (kg)	BW-C <sub>2</sub> Centile	BW-C <sub>2</sub> (kg)
Median	25.0	40.50	37.5	44.50	50.0	50.00
Lower quartile	17.5	33.50	25.0	37.50	50.0	44.00
Upper quartile	37.5	47.50	50.0	52.00	62.5	56.00
Qvartile range	20.0	14.00	25.0	14.50	12.5	12.00

**TABLE 4**  
BODY WEIGHT OF ALL THREE GROUPS OF CHILDREN CONCERNING GENDER DURING THREE CHECKUPS (Mann-Whitney U test)

	The first group		The second group		The third group	
	Z adjusted	p – level	Z adjusted	p – level	Z adjusted	p – level
BW-Dg	-0.473	0.636	1.114	0.265	-0.265	0.791
BW-C <sub>1</sub>	-0.157	0.875	1.271	0.204	-0.265	0.791
BW-C <sub>2</sub>	0.371	0.711	1.221	0.222	0.106	0.915

control checkup one and half year after introducing gluten-free diet.

Table 2 shows the body weight in centile for the second group of children with celiac disease (age 20 – 111 months). Results show that the body weight was under 15.0<sup>th</sup> centile in 50% of children when celiac disease was established before introducing gluten-free diet. At first control checkup 6 months after introducing gluten-free diet, 50% of children had body weight of 25.0<sup>th</sup> centile and more. At the second control checkup (one and half year of gluten-free diet) 50% of children had body weight by 50.0<sup>th</sup> centile and more.

Table 3 shows the centile values of body weight for the third group of children with celiac disease (age 115–204 months). The results show that 50% of children had the body weight under 25.0<sup>th</sup> centile in time when celiac disease was established. After 6 months of gluten-free diet at the first control checkup the children had the body weight at 37.5<sup>th</sup> centile and more. At the second checkup after one and half year of gluten free-diet 50% of children had the body weight at 50.0<sup>th</sup> centile.

Body weight in kilograms for the first group of youngest children (age 6–18 months) is shown in Table 1. At the time of establishing celiac disease children weighed

less than 8.15 kg. At the first control checkup in 50% of children the body weight increased to 10.10 kg, but at the second control checkup 50% of children reached 12.70 kg and more. The results of Friedman test showed that there was at least one measurement which is statistically more significant from the others ( $\chi^2=32000$ ,  $p=0.000$ ).

Figure 1 shows Box and Whisker Plot diagram for the first group of children in relation to body weight in 3 checkups.

In Table 2 the body weight in kilograms for the second group of children (age 20–111 months) during three checkups (first examination and two control checkups) is shown. At the time of establishing diagnosis of celiac disease 50% of children had body weight less than 17 kg. At first control check up in 50% of children, the body weights increased to 18.35 kg and more and at the second control checkup 50% of children gained the body weight more than 22.00 kg. Results of Friedmans test show that there is at least one measurement which is statistically different from the others. ( $\chi^2=28.000$ ,  $p=0.000$ )

In Figure 2 Box and Whisker Plot diagram for the second group of children in relation to body weight in 2 control checkups is shown.

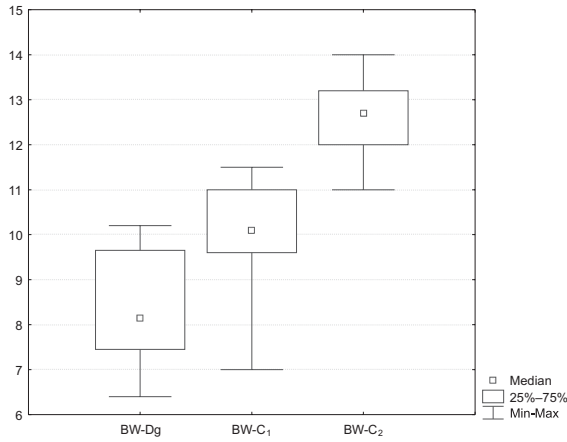


Fig. 1. Box and Whisker Plot diagram of the first group of children according to the body weight in kilograms during three checkups.

Body weight in kilograms for the third group of children (age 115–204 months) is shown in Table 3. Their weight at the first examination was less than 40.50 kg. At the first control checkup they had more than 44.50 kg. At the second control checkup they had more than 50.00 kg. The results of Friedman test demonstrate that there is at least one measurement which is statistically different from others ( $\chi^2=24000$ ,  $p=0.000$ ).

In Figure 3 is Box and Whisker Plot diagram for the third group of children according to body weight in three checkups, is presented.

Statistical testing proves that the differences have been seen in Box and Whisker Plot diagram among three control checkups for all three groups of children.

Table 4 shows the results of Mann–Whitney U test for all three groups of children divided between gender according to body weight measured at the first examination and two control checkups. When the results were statistically calculated, no difference in weight between male and female patients was found.

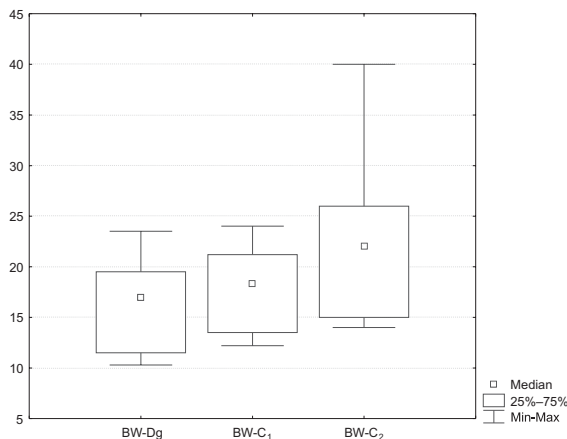


Fig. 2. Box and Whisker Plot diagram of the second group of children according to the body weight in kilograms during three checkups.

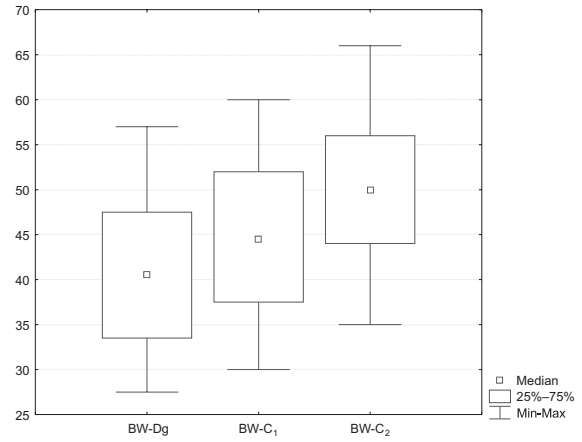


Fig. 3. Box and Whisker Plot diagram of the third group of children according to the body weight in kilograms during three checkups.

BW-Dg body weight of children when the diagnosis of celiac disease was established, BW-C<sub>1</sub> body weight of children at the first control checkup, BW-C<sub>2</sub> body weight of children at the second control checkup expressed by centile and in kilograms.

BW-Dg body weight of children when the diagnosis of celiac disease was established, BW-C<sub>1</sub> body weight of children at the first control checkup, BW-C<sub>2</sub> body weight of children at the second control checkup by centile and in kilograms.

BW-Dg body weight of children when the diagnosis of celiac disease was established, BW-C<sub>1</sub> body weight of children at the first control checkup, BW-C<sub>2</sub> body weight of children at the second control checkup by centile and in kilograms.

## Discussion

The results of our study also confirm that the gluten-free diet is the fundamental for curing celiac disease. The success of gluten-free diet is presented in the results of our study. The children’s body weight was expressed in centile during three measurements after the diagnosis was established. The first control measurement was after 6 months and the second one year afterwards (18 months after introducing gluten-free diet). At the first and the second control checkup the body weight increased evidently. In the first group of children at the time of establishing the diagnosis of celiac disease the children by 7.5<sup>th</sup> centile increased their body weight at the first control check up by 25.0<sup>th</sup> centile and more as well as at the third measurement by 25.0<sup>th</sup> centile and more. It is especially evident the gaining of weight in the second group of children who had the body weight at the first measurement 15.0<sup>th</sup> centile, at the first control check up to 25.0<sup>th</sup> centile and at the second control checkup 50.0<sup>th</sup> centile and more. In the third group of children the gaining of weight was also observed. At the first examination it was 25.0<sup>th</sup> centile, at the second



check up 37.5<sup>th</sup> centile and at the second checkup 50.0<sup>th</sup> centile and more.

The statistical significance of difference has been confirmed by Friedman test. The three body weights expressed in kilograms during three checkups for all three groups calculated by the basic statistical indicator showed that the children gained weight from the time of establishing the diagnosis till the first and second control checkup. Also, the gaining of body weight can be observed by the Box and Whisker Plot diagram for all three groups of children according to body weight at three checkups.

Results of Mann Whitney U-test for all three groups of children show that no statistically significant difference exists concerning body weight between male and female children at the moment of establishing diagnosis of celiac disease as well as at the first and the second checkups. During the gluten-free diet the children of both genders gained weight equally.

It is very important to exclude all products that contain wheat, barley, rye and oat because of gluten<sup>6</sup>. At the beginning when the gluten-free diet was introduced the patients were mostly malnourished, so it is important to provide hypercaloric and hyperproteinemic diet with less fat which contains saturated long chains fat acids and disaharides<sup>10</sup>. It is necessary to ingest 150 kcal/kgBW with the protein intake of 3–4 g proteins/kgBW<sup>20</sup>.

It is necessary to be careful when choosing the food for alimentation. Alimentation without hired gluten is not so easy to provide. There is the problem when some additives, preservatives, stabilizations which can contain gluten, are in question. Gluten can be present in processed, products, medicaments, and cosmetic products. Various foods which should not contain gluten can contain it as hydrolysed vegetable protein (HVP) and modified food. It is equally important to read declarations of the ingredients of processed products to prove if they contain gluten<sup>21</sup>. The great problem for the patient is a small choice of gluten-free products at the Croatian market. Then the products are not all declared of being glu-

ten-free with the characteristic sign of crossed ear of grain in the circle<sup>2</sup>. The gluten-free food is also more expensive<sup>19</sup>. The quality of patient's life with celiac disease should be better if products were cheaper and if they had precise declaration<sup>3</sup>. The situation would be even better if there were more products at the Croatian market.

## Conclusion

Gluten-free diet is necessary and only adequate for the patient with celiac disease as a therapy of regeneration of villous atrophy of small intestine, providing better absorption of nutrients, the gaining of body weight, preventing the development of lymphomas of the gut and relapse of the celiac disease<sup>6</sup>. The diet should be provided for the whole life. Applying the gluten-free diet gives a good prognosis. After introducing gluten-free diet, the period of the recovery of the mucosa of small intestine may be from 2–3 weeks till 6 months depending on pathohistological findings. One of the best indicators of recovery is the gaining of body weight and disappearing of the clinical symptoms like dermatitis herpetiformis, evident changes of dental enamel, osteoporosis, and retardation in puberty or infertility<sup>10</sup>. The results of the study show that the strict application of gluten-free diet is protective concerning the development of enteropathy-associated T cell lymphoma<sup>13</sup>. It can be concluded that celiac disease is easy to diagnose if one bears it in mind. The patients can live healthy life if they are on the gluten-free diet long life<sup>1</sup>.

We can conclude that the process of celiac disease healing is only achieved by gluten-free diet. At the time of establishing the diagnosis, the children with celiac disease had lower body weight compared to the healthy children. It was proved by our results that the body weight expressed in centile and kilograms of children with celiac disease, after the period of six months and especially after 18 months at the second control examination gained weight and had body weight like healthy children of the same age and gender.

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*M. Lukić*

*Department of Nutrition, University Hospital Center Osijek, J Hüttlera 4, 31000 Osijek, Croatia*  
*e-mail: lukic.marko@kbo.hr*

## **UČINKOVITOST BEZGLUTENSKE PREHRANE NA TJELESNU MASU KOD DJECE S CELIJAKIJOM**

### **S A Ž E T A K**

Cilj ovog rada bio je praćenje i kontrola tjelesne mase kod djece s dijagnosticiranom celijakijom nakon uvođenja dijete bez glutena određeno vrijeme. Prospektivna klinička studija uključuje 42 djece s dijagnosticiranom celijakijom kod kojih je mjerena tjelesna masa prvi put prije uvođenja bezglutenske dijete, a zatim na prvom kontrolnom pregledu nakon 6 mjeseci te na drugom 18 mjeseci nakon uključivanja dijete bez glutena. Izmjerena tjelesna masa zatim je uspoređena s centilnim tablicama za odgovarajuću dob djece. Nakon uvođenja bezglutenske dijete tjelesna masa djece se značajno povećala u usporedbi s centilnim tablicama odgovarajuće dobi na prvom kontrolnom pregledu a naročito na drugom. Kontrolom tjelesne mase s obzirom na spol djece razlika nije primijećena za vrijeme dijagnosticiranja ni na prvom a ni na drugom kontrolnom pregledu. U zaključku bi mogli navesti da je izuzetno važno što ranije dijagnosticirati celijakiju kako bi se što ranije uvela dijeta bez glutena i na taj način na vrijeme spriječiti fizičko zaostajanje djece kao i mnoga druga patološka stanja koja nastaju kao posljedica oštećenja sluznice crijeva i nemogućnost apsorpcije hranjivih tvari potrebni za razvoj djece.