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The Effect of Aerobic and Anaerobic Physical Training on the Absorptive Cells, Absorption of Carbohydrate and Protein in Small Intestine

I Nyoman Kanca [a]
I Ketut Iwan Swadesi [b]
I Ketut Yoda [c]
I Made Agus Wijaya [d]

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Abstract

The purpose of this study is to investigate the morphofunctional response of a total number of absorptive cells, and carbohydrate and protein absorption capability in the small intestine of Rattus norvegicus strain Wistar (RNSW) that has been subjected to aerobic and anaerobic physical training based on the morphofunctional physiological paradigm. This study was based on the separate sample pretest-posttest control group design, using a t-test, and multivariate SPSS ten program, with five percent level of significance. The sample consisted of one hundred and twenty, male RNSW, with average age of five months, and body weight of 246-278 grams. They were divided into twelve groups at random, i.e. four pretest groups, two control groups, and six treated groups where different diets were given thirty minutes before undergoing posttest. The experimental animals underwent four weeks physical training (twelve times), three groups were given aerobic physical training by swimming with a burden of three percent fasting body weight, the others three groups received anaerobic physical training by swimming with a burden of nine percent fasting body weight. The experiment was conducted at night, between 7.30 PM to 10.30 PM, in a water with a temperature of 28°C to 30°C. Result of the study revealed: (1) Aerobic and anaerobic physical training, increased the number of absorptive cells (t = -73,281, p = 0,000), and increased the absorptive capacity of carbohydrate and protein (Hotelling's Trace = 0,244, p = 0,000). (2) There was a difference in the increased absorptive capacity of carbohydrate and protein among groups (Hotelling's Trace = 0,404a, p = 0,000). Aerobic physical training had less influence than anaerobic physical training on the increased number of absorptive cells, and the absorptive capacity of carbohydrate and protein in the small intestine. In conclusion: (1) Aerobic physical training of swimming with a burden of three percent fasting body weight, and anaerobic physical training of swimming with a burden nine percent fasting body weight correlate with the increase the number of absorptive cells, and carbohydrate and protein absorptive capacity of the small intestine. (2) Anaerobic physical

[a] Ganesha Education University Singaraja, Bali, Indonesia
[b] Ganesha Education University Singaraja, Bali, Indonesia
[c] Ganesha Education University Singaraja, Bali, Indonesia
[d] Ganesha Education University Singaraja, Bali, Indonesia

training of swimming with a burden nine percent fasting body weight has better correlation than aerobic physical training of swimming with a burden of three percent fasting body weight with the increased number of absorptive cells, and the absorptive capacity of carbohydrate and protein in the small intestine.

Author correspondence:
I Nyoman Kanca,
Sports and Health Faculty
Ganesha Education University Singaraja, Bali, Indonesia
Email address: *kanca.nyoman@yahoo.co.id*

1. Introduction

An athlete needs and uses much energy which comes from nutrients. To be able to do a training and join a competition in a more optimal condition the athlete needs energy coming from a larger amount of higher quality, more digestible nutrient which small intestines can more easily absorb.

Carbohydrate is very important in our body as energy substance and it is very useful to an athlete in a kind of sport which uses speedy (short) time with high intensity whereas protein serves as material substance that keeps the body condition and development well. Some research findings show that after a sprint with high-intensity significant increase in small intestinal permeability occurs (Pals, 1997). The composition of solution can have a significant effect on water absorption speed in different intestinal parts after a training (Lambert, 1997). An hour after a moderate training can increase iron absorption speed (Schmid, 1996). Swimming has a positive effect on a number of cells and a sprint has an effect on the increase in the number of cells (Praag, 1999).

Gastrointestinal dysfunction especially in small intestines, particularly the prevalence number of indigestion and malabsorption is still very high (Soeparto, 1999). Maldigestion or malabsorption is a condition that causes less efficient assimilation from nutrient digestion both as the result of maldigestion and malabsorption (Ulshen, 1996; Soeparto, 1999).

One of the causes of malabsorption is a low small intestinal function that makes it unable to serve an optimal function as the result of less than an adequate number of daily activities to stress absorption system function. If the low quality small intestinal absorption system function continues, it will cause human resources to have low nutrient status, problems in fitness and physical health who have low performance and low sports achievement. One of the significant efforts that can be made to avoid that condition or to improve it is through aerobic and anaerobic physical training.

This study used Rattus Norvegicus Strain Wistar (RNSW) as a sample and since in each analysis unit a sample member is killed, it is not possible to use humans as a sample in this study. The problems under study were (1) Is there any effect of aerobic and anaerobic physical training on carbohydrate (glucose), protein absorption and small intestinal absorptive cells? (2) Is there any difference in the effect of aerobic and anaerobic physical training on carbohydrate (glucose) and protein absorption and small intestinal absorptive cells?

This study aimed at studying the carbohydrate (glucose) and protein absorption and small intestinal absorptive cells after being given aerobic and aerobic and anaerobic physical training based on a biologic paradigm with the morpho-function concept.

2. Materials and Methods

This study belonged to a laboratory experiment. The design used separate sample pretest-posttest control group design (Campbell, 1966). The sample animal, i.e., RNSW, aged ± 1 month, were reared until they were 5 months old. The data were analyzed by statistical t-test and multivariate analysis using SPSS program version ten.

The number of sample animal was 120 heads + 24 heads of male as a reserve which were selected at random. The sample was divided at random into 12 groups, i.e., 4 pretest groups, 2 control groups (1 fasting control group, and 1 control group which was given standard diet before posttest) and 6 treatment groups, each of which consisted of 10 heads and 2 heads of the reserve. The sample animal was given a standard diet of KP3 CP124 pellets produced by PT. Charoen Pokphand Indonesia Mojokerto.

The training was done 4 weeks with 3 times a week and took place every Monday, Wednesday, and Friday at 19.30 West Indonesia Time, at 28°-30°C. The animals were not fed for 16 hours (Smith, 1994) and were fed 30 minutes before the pretest and posttest. The feeding before the pretest and posttest was done by spoon- feeding to give equal a dose to every animal according to each group, i.e.,

a) The groups were fed with the standard diet, every animal in the sample was fed with 2.5-gram standard diet which was inserted into a tube mixed with 5 ml aqua water and was stirred evenly and then was given to the sampled animal by spoon-feeding 30 minutes before pretest and posttest.
b) The groups were fed the standard diet + glucose, every animal was fed with 2.5-gram standard diet + 2.5-gram amino acid + 2.5 ml aqua water inserted into a tube and was stirred evenly and then was fed to the sampled animal by spoon-feeding 30 minutes before pretest and posttest.
c) The groups were fed the standard diet + amino acid + 2.5 ml aqua water inserted into a tube and was stirred evenly and then was fed to the sampled animal by spoon- feeding 30 minutes before pretest/posttest.

After the aerobic physical training (the body weight reduced as much as 3% of the fasting body weight and after the anaerobic physical training (the body weight reduced as much as 9% of the fasting body weight) on the last day of the period in which the sampled animal was let to rest for 32 hours (having a rest for 16 hours during which time the animal was given food and drink and then it was fasting for 16 hours), then a posttest was administered.

The material for carbohydrate (glucose) and blood protein examination in the pretest and posttest were taken from vena porta at the 30th minute after the diet by using Stera brand 5 ml disposable syringe. 4-5 ml blood was taken after the sampled animal was given anesthesia by giving ether inhalation. The highest nutrient absorption occurred in the jejujunum small intestine (Ganong, 2001; Guyton, 2000).

The examination of the dependent variable was done for (1) carbohydrate (glucose) in the blood examined by method O'Toluidin. (2). Blood protein (total protein) was examined by method Biuret. (3). The absorptive cells were examined by method Periodic Acid Schiff (PAS). The data analysis used t-test and MANOVA at 95% level of significance.

3. Results and Discussions

3.1 Result

Table 1 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in Vena Porta in the Group Fed with the Standard Diet (Control) and the Group doing Aerobic Physical Training Fed with the Standard Diet (Posttest)

Table 1
Group doing Aerobic Physical Training Fed with the Standard Diet (Posttest)

Variable	Standard Diet (Control)		Aerobic+Standard Diet (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	217.00	10.549	422.300	14.267	-36.445	0.000
Blood glucose	154.970	20.670	160.991	61.048	1.667	0.026
Blood protein	7.013	0.827	7.557	2.116	-0.757	0.027

Note: blood glucose and blood protein (mg %), SD = standard deviation, p = probability

Table 1 shows in the group doing aerobic physical training and fed the standard diet 30 minutes before the posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0.05).

Table 2 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein between the Group Fed with the Standard Diet (Pretest) and the Aerobic Group Fed with the Standard Diet (Posttest)

Table 2
Group Fed with the Standard Diet (Pretest) and the Aerobic Group Fed with the Standard Diet (Posttest)

Variable	Standard Diet (Pretest)		Aerobic+Standard Diet (Posttest)		T	p
	Mean	SD	Mean	SD		
Number of absorptive cells	218.700	10.467	422.300	14.267	-36.384	0.000
Blood glucose	123.913	18.404	160.991	61.048	-1.839	0.000
Blood protein	6.336	0.720	7.557	2.116	-1.727	0.001

Table 2 shows in the group doing aerobic physical training group and fed the standard diet 30 minutes before posttest that the absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0,05).

Table 3 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Fed with Standard Diet+Glucose (Pretest) and the Group who did Aerobic Physical Training and was Fed with the Standard Diet +Glucose (Posttest)

Table 3
Group who did Aerobic Physical Training and was Fed with the Standard Diet +Glucose (Posttest)

Variable	Standard Diet+ Glucose (Pretest)		Aerobic Standard Diet+ Glucose (Posttest)		T	p
	Mean	SD	Mean	SD		
Number of absorptive cells	228.500	21,407	453.400	9.276	-30.483	0.000
Blood glucose	172.916	32,244	189.972	26.586	-1.291	0.000
Blood protein	5.759	0,351	6.221	0.464	-2.508	0.022

Table 3 shows in the group doing aerobic physical training and fed with the standard diet+glucose 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0.05).

Table 4 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein between the Group Fed with Standard Diet+Amino Acid (Pretest) and the Group that did Aerobic Physical Training and was Fed with the Standard Diet +Glucose (Posttest)

Table 4
Group that did Aerobic Physical Training and was Fed with the Standard Diet +Glucose (Posttest)

Variable	Standard Diet + Amino Acid (Pretest)		Aerobic with Standard Diet +Amino Acid (Posttest)		T	p
	Mean	SD	Mean	SD		
Number of absorptive cells	227.900	17.155	442.100	14.208	-30.408	0.000
Blood glucose	159.344	24.741	190.388	23.158	-2.897	0.010
Blood protein	5.526	0.530	6.130	0.195	-3.377	0.003

Table 4 shows in the group doing aerobic physical training and was fed with the standard diet 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0.05).

Table 5 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Fed with Standard Diet (Pretest) and the Group that did Aerobic Physical Training and was Fed with the Standard Diet (Posttest)

Table 5
Group that did Aerobic Physical Training and was Fed with the Standard Diet (Posttest)

Variable	Standard Diet (Pretest)		Anaerobic with Standard Diet (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	218.700	10.467	441.800	21.857	-29.112	0.000
Blood glucose	123.913	18.404	204.968	35.064	-6.473	0.000
Blood protein	6.336	0.720	6.651	0.791	0.842	0.026

Table 05 shows in the group doing anaerobic physical training and was fed with standard diet 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0.05).

Table 06 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Fed with Standard Diet (Control) and the Group that did Aerobic Physical Training and was Fed with the Standard Diet (Posttest).

Table 6
Group that did Aerobic Physical Training and was Fed with the Standard Diet (Posttest).

Variable	Standard Diet (Control)		Anaerobic with Standard Diet (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	217.800	10.549	441.800	21.857	-29.187	0.000
Blood glucose	194.970	20.670	204.968	35.064	-0.777	0.010
Blood protein	7.013	0.827	6.051	0.791	2.656	0.016

Table 6 shows in the group that did anaerobic physical training and was fed with the standard diet 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0.05).

Table 7 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Fed with Standard Diet +Glucose (Pretest) and the Group that did Anaerobic Physical Training and was Fed with the Standard Diet +Glucose (Posttest).

Table 7
Group that did Anaerobic Physical Training and was Fed with the Standard Diet +Glucose (Posttest).

Variable	Standard Diet + Glucose (Pretest)		Anaerobic with Standard Diet +Glucose (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	452.900	9.314	441.900	10.148	2.525	0.021
Blood glucose	172.916	32.244	186.224	34.040	0.451	0.000
Blood protein	5.759	0.351	6.796	0.841	-3.597	0.002

Table 7 shows in the group doing anaerobic physical training and was fed with the standard diet + glucose 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly (p<0.05).

Table 8 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Fed with Standard Diet+Amino Acid (Pretest) and the Group that did Aerobic Physical Training and was Fed with the Standard Diet+Amino Acid (Posttest)

Table 8
Group that did Aerobic Physical Training and was Fed with the Standard Diet+Amino Acid (Posttest)

Variable	Standard Diet+Amino Acid (Pretest)		Anaerobic with Standard Diet+Amino Acid (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	227.900	17.155	445.100	11.298	-33.436	0.000
Blood glucose	159.344	24.741	191.637	68.228	-1.407	0.030
Blood protein	5.526	0.530	7.385	0.886	-5.691	0,000

Table 8 shows in the group doing anaerobic physical training and was fed with the standard diet+amino acid 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein in vena porta increased significantly ($p<0.05$).

Table 9 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Doing Aerobic Physical Training and the Group Doing Anaerobic Physical Training and was Fed with the Standard Diet (Posttest)

Table 9
Group Doing Anaerobic Physical Training and was Fed with the Standard Diet (Posttest)

Variable	Aerobic+Standard Diet (Posttest)		Anaerobik+Standard Diet (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	422.300	14.267	441.800	21.857	-2.362	0.030
Blood glucose	160.991	61.048	204.968	35.064	-1.975	0.000
Blood protein	7.557	2.116	6.051	0.791	2.108	0.049

Table 9 shows the result of the observation of the group that did aerobic physical training and the group that did anaerobic physical training and was fed with the standard diet 30 minutes before posttest that the numbers of absorptive cells, glucose, and blood protein differed significantly ($p<0.05$). This shows that the number of blood protein in vena porta increased in a greater number in the group that did aerobic physical training than the group that did anaerobic physical training while the number of absorptive cells and blood glucose in vena porta in the group that did aerobic physical training increased in a smaller number than the group that did anaerobic physical training.

Table 10 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Doing Aerobic Physical Training and the Group Doing Anaerobic Physical Training and was Fed with the Standard Diet +Glucose

Table 10
Group Doing Anaerobic Physical Training and was Fed with the Standard Diet +Glucose

Variable	Aerobik with Standard Diet+Glucosa (Posttest)		Anaerobic with Standard Diet+Glucosa (Posttest)		t	p
	Mean	SD	Mean	SD		
Number of absorptive cells	453.400	9.276	441.900	10.148	2.645	0.000
Blood glucose	189.972	26.586	166.224	34.040	1.739	0.010
Blood protein	6.221	0.464	6.796	0.841	-1.892	0.003

Table 10 shows the result of the observation of the group that did aerobically and the group that did anaerobic trainings that were fed the standard diet + glucose 30 minutes before posttest that the number of absorptive cells, blood glucose, and blood protein differed significantly ($p<0.05$). This shows that blood glucose in vena porta increased in a higher number in aerobic physical training than in anaerobic physical training while the number of absorptive cells and blood protein in vena porta increased in a smaller number in aerobic physical training than in anaerobic physical training.

Table 11 Result of the Observation of the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group Doing Aerobic Physical Training and the Group Doing Anaerobic Physical Training and was Fed with the Standard Diet (Posttest)

Table 11
Group Doing Anaerobic Physical Training and was Fed with the Standard Diet (Posttest)

Variable	Aerobic with Standard Diet +Amino Acid (Posttest)		Anaerobic with Standard Diet+Amino Acid (Posttest)		t	p
	Mean	SD	Mean	SD		
Absorptive cells	422.100	14.208	445.100	11,298	-0.523	0.000
Blood glucose	190.388	23.158	191.637	68.228	-0.055	0.022
Blood protein	6.130	0.195	7.385	0.886	-4.374	0.000

Tabel 11 shows the result of the observation of the groups doing aerobic and anaerobic physical training fed the standard diet + amino acid 30 minutes before posttest that the number of absorptive cells, blood glucose and blood protein differed significantly ($p<0.05$). This shows that the number of absorptive cells, blood glucose and blood protein in vena porta in aerobic physical training increased in a smaller number than in anaerobic physical training.

Table 12 Test of Differences in the Number of Absorptive Cells, Blood Glucose and Blood Protein in the Group that did Aerobic Physical Training and Anaerobic Physical Training (Posttest)

Table 12
Group that did Aerobic Physical Training and Anaerobic Physical Training (Posttest)

Variable	Aerobic Physical Training (Posttest)		Anaerobic Physical Training (Posttest)		p
	Mean	SD	Mean	SD	
Absorptive cells	439.266	17.984	442.933	14.908	0.000
Blood glucose	180.450	41.693	187.609	49.528	0.000
Blood protein	6.636	1.744	6.744	0.982	0.000

Hotelling's Trace = 0,404[a] *p = 0.000* *Glucose and blood protein (mg %)*

The analysis used multivariate statistics (*Hotelling's Trace*). The result shows that the effect of aerobic and anaerobic physical training on the increase in the number of absorptive cells, glucose (carbohydrate) and protein (total protein) absorption in small intestine differ significantly ($p<0,05$), Hotelling's Trace value = 0,404[a] ($p=0,000$). This shows that the number of absorptive cells, carbohydrate (glucose) and protein (total protein) absorption in small intestine increased in a smaller number in aerobic physical training than in anaerobic physical training ($p<0,05$).

3.2 Discussion

Physical Training

The basic practice in aerobic physical training is that the physical training with a load, and light intensity (medium) up to sub-maximum done continually over a relatively long period of time. The swimming program with a load 3% of the fasting weight done continually with a medium intensity for a relatively long period in accordance with the training program is a dosage of an aerobic physical training. The load of 3% of the fasting weight is tied 5 cm from the tip of the tail (McArdle & Montage, 1966). The animal is said to be tired if it cannot lift up its head any longer above the water surface, i.e., for 10 seconds (McArdle & Montage, 1966).

The practice in an anaerobic physical training is to give a maximum load with a high intensity (quickly) done in a relatively short time and is repeated intermittently several times. Swimming training with a load of 9% of the fasting weight done intermittently with a high intensity is a dosage of an anaerobic physical training program. The load of 9% of the fasting weight was tied 5 cm from the tip of the tail (McArdle & Montage, 1966). The training is done 3 sets with 3 repetitions of each set, the resting time is at a 60-second interval and the resting time for each set equals to 3 times as long as the resting time for each interval (Fox, 1984). The giving of the same dosage to an aerobic physical training as to an anaerobic physical training in this study was based on the result of the try-out duration of the swimming training. Thus the training was done on days 1, 2, 3, 4 for 45 minutes, on days 5, 6, 7, 8 for 48 minutes and on days 9, 10, 11, 12 for 51 minutes. The length of time of the training was made relatively equal to that of the training program so that the difference in dosage between the aerobic training and the anaerobic physical training lay in the load and intensity of the training.

Adaptation as the Effect of a Physical Training

Small intestine adaptation is a change in mucosal structure, sitokinetics of the digestive and absorptive function that occurs as a response to various stimuli, hormonal and dietary change (Dowling, 1988). There is a predominance of the oxidative system to supply the energy cost of judo matches from the first minute of combat up to the end, compared with the anaerobic systems (Ursula F, 2017).

Aerobic and anaerobic physical training with the frequency 3 x 1 week for 4 weeks is a physical stressor that can be conditioned, which results in the body to be able to adapt itself and at the same time to able to improve and increase its functional system. A physical training is essentially something given to the body to produce an adaptation that can increase its functional capacity (Davis *et al.*, 1997; Viru & Smirnova, 1995). Completion of a morning swimming session alone or together with resistance exercise can substantially enhance sprint-swimming performance completed later the same day (Courtney, 2017).

Body's adaptability will increase according to a load of stress given (Dick, 1992; Rushall, 1992). The form of body's adaptation to the physical training program is reflected in the performance of the physical movement (Garagiola, 1995). A dosage of physical training that suits the body's response can act as a stimulator (Rushall, 1992). The growth hormonal level in an individual will increase if the individual is active or doing a sport. (Soewondo, 1996). The physical training causes improvement in the growth hormonal secretion in the blood (Lamb, 1984). It can increase the number of cells (Praag, 1999). Ice-mile swimmers may become hypothermic while swimming and the post-swim body temperature after drop may expose them to dangerous levels of hypothermia. Pace and respiratory rate should be monitored for hypothermia for at least 1 hour (John Kenny, 2017). The increase in mucosal layers causes the gradual increase in intestine mucosal surface area. Increase in absorption per intestine length unit seems to be the effect of the increase in absorption surface area that is caused by mucosal dilatation and hyperplasia (Soeparto, 2003).

Alter a meal, the level of blood glucose increases for ± 30 minutes and gradually returns to its fasting level (70-100mg/100ml) alter 90-180 minutes (Almatsier, 2001). A slow absorption occurs alter a drink containing 12% glucose during an intermittent training (Davis, 1998). The glucose absorption increases significantly in gastrointestinal alter drinking a supplement drink containing caffeine during the training (Van Nieuwenhoven, 2000). During the absorption blood circulation in villi and submucosal layers increases, an increase in blood circulation in mesenteric superior artery generally occurs after a meal (Sanford, 1992; Sieber, 1991). Water and nutrient absorption mostly occurs in the upper part of the small intestine during the training (Maughan, 1999). Insulin hormone is very important in controlling the physiology of glucose or plasma protein use. More than 99% the final digestión product of protein absorbed is in the form of single amino acid (Guyton, 2000). A regular physical training can increase body's organ physiologic ability by 25% (McArdle, 1986).

Amino acid absorbed in small intestine enters blood circulation via vena porta (Almatsier, 2001). After eating food containing protein a sharp temporary increase occurs in portal blood amino nitrogen. Most of the protein being absorbed passes luminaire membrane of intestinal epithelial cells (small intestinal entero cite) in the form of dipeptide, tripeptide, dan some free amino acids (Ganong, 2001; Guyton, 2000).

A training done 3 x 1 week for 4 weeks can correct glucose metabolism (Jun 1994). A physical training with a high intensity for 8 weeks increases glucose metabolism (Fuji, 1992). Cycling for 60 minutes improves growth hormone (GH) and insulin-like growth factor-1 (IGF-1) (Manetta, 2002). Heavy training improves GH, growth hormone releasing hormone (GHRH) (de Vries, 2002). Stamina training with a high intensity increases GH and IGF-I system activity (Lacour, 2002). At the threshold anaerobic training increases GH, prolactin (Gursel, 2001). Anaerobic training increases cortisol concentration, GH dan decreases insulin concentration (Viru, 2001). TGF-α and TGF-β play a role in the regulation of the balance between proliferation and change of epithelia cells. The TGT-α the proliferative effect is balanced by the TGF- β (Roy, 1995 in Soeparto *et al.*, 2003).

Thus, in the physical training program with a low and médium intensity cant increase growth hormone (Widemen, 2000) and IGF-1 (Lacour, 2002) and IL-6 (Harbuz, 1992; Pedersen, 2000). The increase in growth hormone and IGF-1 can increase hyperplasia through epidermal growth factor mechanism (EGF) (Beaulieu, 1981; Opleta-Madsen, 1991; Burrin, 1995). The increase in activity in EGF can increase Na=glocose cotransporter-1 (SGLT1) (Chung, 1999). IL-6 was known to play a role in increasing small intestinal brush border (Scott, 2000; Zhou, 2003). On the grounds of the two hormonal mechanisms and cytokine above, then the physical training can increase the absorption ability in small intestine.

The findings in this study show that physiologic adaptation occurs in the effort in which the small intestine functionally adapts its need for nutrients so that a change in the small intestine mucosal structure for nutrients, cytogenetics of the digestive and absorptive function occurs as a physical aerobic training as a response to anaerobic training with a load of 3% fasting body weight and anaerobic training as the response to the aerobic training with a load of 3% the fasting weight and an anaerobic training with a load of 9% the fasting body weight which become the stressor of the body that is conditioned.

4. Conclusion

(1) Aerobic physical training of swimming with a burden of three percent fasting body weight and anaerobic physical training of swimming with a burden nine percent fasting body weight correlate with the increase the number of absorptive cells, and carbohydrate and protein absorptive capacity of the small intestine.
(2) Anaerobic physical training of swimming with a burden nine percent fasting body weight has a better correlation than the aerobic physical training of swimming with a burden of three percent fasting body weight with the increased number of absorptive cells, and the absorptive capacity of carbohydrate and protein in the small intestine.

Suggestion

The findings of this study are the initial steps in further research to reveal in the more comprehensive manner the effect of aerobic physical training with a load of 3% of the fasting body weight and anaerobic physical training with a load of 9% of the fasting body weight on the nutrients in small intestines. Some suggestions need to be made which include: (1). It is hoped that the newly developed concept can be investigated involving other material to enhance the small intestine morphofunctional to optimize achievement of athletes. (2). Aerobic physical training with a load of 3% of the fasting body weight and anerobic training with a load of 9% the fasting body weight can be expected to be investigated by using animals as the guinea pigs whose body organs physiological functions are relatively similar to those of the human so that the findings can be applied to human. (3). This study should be done clinically with a human to have a more relevant application.

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Statement of authorship
The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

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References

Almatsier, S. (2002). *Prinsip dasar ilmu gizi*. Gramedia Pustaka Utama.

Beaulieu, J. F., & Calvert, R. (1981). The effect of epidermal growth factor (EGF) on the differentiation of the rough endoplasmic reticulum in fetal mouse small intestine in organ culture. *Journal of Histochemistry & Cytochemistry*, *29*(6), 765-770. https://doi.org/10.1177%2F29.6.6265548

Burrin, D. G., Davis, T. A., Ebner, S., Schoknecht, P. A., Fiorotto, M. L., Reeds, P. J., & McAvoy, S. (1995). Nutrient-independent and nutrient-dependent factors stimulate protein synthesis in colostrum-fed newborn pigs. *Pediatric Research*, *37*(5), 593. https://doi.org/10.1203/00006450-199505000-00006

Cameron-Smith, D., Collier, G. R., & O'dea, K. (1994). Effect of soluble dietary fibre on the viscosity of gastrointestinal contents and the acute glycaemic response in the rat. *British Journal of Nutrition*, *71*(4), 563-571. https://doi.org/10.1079/BJN19940163

Chung, B. M., Wong, J. K., Hardin, J. A., & Gall, D. G. (1999). Role of actin in EGF-induced alterations in enterocyte SGLT1 expression. *American Journal of Physiology-Gastrointestinal and Liver Physiology*, *276*(2), G463-G469. https://doi.org/10.1152/ajpgi.1999.276.2.G463

Davis, J. M., Burgess, W. A., Slentz, C. A., Bartoli, W. P., & Pate, R. R. (1988). Effects of ingesting 6% and 12% glucose/electrolyte beverages during prolonged intermittent cycling in the heat. *European journal of applied physiology and occupational physiology*, *57*(5), 563-569. https://doi.org/10.1007/BF00418463

de Vries, W. R., Abdesselam, S. A., Schers, T. J., Maas, H. C., Osman-Dualeh, M., Maitimu, I., & Koppeschaar, H. P. (2002). Complete inhibition of hypothalamic somatostatin activity is only partially responsible for the growth hormone response to strenuous exercise. *Metabolism-Clinical and Experimental*, *51*(9), 1093-1096.

Dowling, R. H., Hussaini, S. H., Murphy, G. M., Besser, G. M., & Wass, J. A. H. (1992). Gallstones during octreotide therapy. *Metabolism*, *41*(9), 22-33. https://doi.org/10.1016/0026-0495(92)90027-8

Fujii, S. (1992). Physical exercise therapy in diabetes mellitus--the role of clinical laboratory examinations. *Rinsho byori. The Japanese journal of clinical pathology*, *40*(11), 1129-1135.

Ganong, W. F. (2001). Hormonal control of calcium metabolism and the physiology of bone. *Review of medical physiology*, 369-382.

Garagiola, U., Buzzetti, M., Cardella, E., Confalonieri, F., Giani, E., Polin, V., ... & Pecori, A. (1995). Immunological patterns during regular intensive training in athletes: quantification and evaluation of a preventive pharmacological approach. *Journal of international medical research*, *23*(2), 85-95. https://doi.org/10.1177%2F030006059502300201

Gürsel, Y., Ergin, S., Ulus, Y., Erdoğan, M. F., Yalçın, P., & Evcik, D. (2001). Hormonal responses to exercise stress test in patients with fibromyalgia syndrome. *Clinical rheumatology*, *20*(6), 401-405. https://doi.org/10.1007/s100670170003

Guyton, A. C., & Hall, J. E. (2000). The pituitary hormones and their control by the hypothalamus. *Textbook of medical physiology*, *11*, 918-929.

Harbuz, M. S., Stephanou, A., Sarlis, N., & Lightman, S. L. (1992). The effects of recombinant human interleukin (IL)-1α, IL-1β or IL-6 on hypothalamo-pituitary-adrenal axis activation. *Journal of Endocrinology*, *133*(3), 349-355. https://doi.org/10.1677/joe.0.1330349

Julio, U. F., Panissa, V. L., Esteves, J. V., Cury, R. L., Agostinho, M. F., & Franchini, E. (2017). Energy-system contributions to simulated judo matches. *International journal of sports physiology and performance*, *12*(5), 676-683.

Jun, J. Y. (1994). The effects of programmed jogging on metabolism and cardio-pulmonary function of type II diabetic patients. *Kanhohak t'amgu*, *3*(1), 19-42.

Kenny, J., Cullen, S., & Warrington, G. D. (2017). The "Ice-Mile": Case Study of 2 Swimmers' Selected Physiological Responses and Performance. *International journal of sports physiology and performance*, *12*(5), 711-714.

Lacour, J. R., Kostka, T., & Bonnefoy, M. (2002). Physical activity to delay the effects of aging on mobility. *Presse medicale (Paris, France: 1983)*, *31*(25), 1185-1192.

Lamb, D. R. (1984). Physical of Exercise: Responses & Adaptations.

Lambert, G. P., Chang, R. T., Xia, T., Summers, R. W., & Gisolfi, C. V. (1997). Absorption from different intestinal segments during exercise. *Journal of Applied Physiology*, *83*(1), 204-212. https://doi.org/10.1152/jappl.1997.83.1.204

Manetta, J., Brun, J. F., Maimoun, L., Callis, A., Préfaut, C., & Mercier, J. (2002). Effect of training on the growth hormone-IGF-I axis during exercise in middle-aged men: Relationship with glucose homeostasis. *American Journal of Physiology-Endocrinology and Metabolism*.

Maughan, R. J., & Leiper, J. B. (1999). Limitations to fluid replacement during exercise. *Canadian journal of applied physiology*, *24*(2), 173-187. https://doi.org/10.1139/h99-015

McARDLE, W. D., & Montoye, H. J. (1966). Reliability of exhaustive swimming in the laboratory rat. *Journal of Applied Physiology*, *21*(4), 1431-1434. https://doi.org/10.1152/jappl.1966.21.4.1431

McArdle, W. D., Katch, F. I., & Katch, V. L. (1986). Energy expenditure during walking, jogging, running, and swimming. *Exercise physiology: energy, nutrition, and human performance. 2nd ed. Philadelphia: Lea & Febiger*, 147-65.

McGowan, C. J., Pyne, D. B., Thompson, K. G., Raglin, J. S., & Rattray, B. (2017). Morning Exercise: Enhancement of Afternoon Sprint-Swimming Performance. *International journal of sports physiology and performance*, *12*(5), 605-611. https://doi.org/10.1123/ijspp.2016-0276

Opleta-Madsen, K., Meddings, J. B., & Gall, D. G. (1991). Epidermal growth factor and postnatal development of intestinal transport and membrane structure. *Pediatric research*, *30*(4), 342. https://doi.org/10.1203/00006450-199110000-00010

Pals, K. L., Chang, R. T., Ryan, A. J., & Gisolfi, C. V. (1997). Effect of running intensity on intestinal permeability. *Journal of Applied Physiology*, *82*(2), 571-576. https://doi.org/10.1152/jappl.1997.82.2.571

Pedersen, B. K., & Toft, A. D. (2000). Effects of exercise on lymphocytes and cytokines. *British journal of sports medicine*, *34*(4), 246-251. http://dx.doi.org/10.1136/bjsm.34.4.246

Rowbottom, D. G., Keast, D. A. V. I. D., Garcia-Webb, P. E. T. E. R., & Morton, A. R. (1997). Training adaptation and biological changes among well-trained male triathletes. *Medicine and science in sports and exercise*, *29*(9), 1233-1239. https://doi.org/10.1097/00005768-199709000-00017

Rushall, B. R. (2006). Psychological factors and mental skills in wrestling. *The Sport Psychologist's Handbook. A Guide for Sport-Specific Performance Enhancement*, 375-399.

Sanford, P. A. (1992). *Digestive system physiology*. Arnold.

Scott, K. E., Logan, M. R., Klammer, G. M., Teoh, D. A., & Buret, A. G. (2000). Jejunal Brush Border Microvillous Alterations inGiardia muris-Infected Mice: Role of T Lymphocytes and Interleukin-6. *Infection and immunity*, *68*(6), 3412-3418. http://dx.doi.org/10.1128/IAI.68.6.3412-3418.2000

Sieber, C., Beglinger, C., Jaeger, K., Hildebrand, P., & Stalder, G. A. (1991). Regulation of postprandial mesenteric blood flow in humans: evidence for a cholinergic nervous reflex. *Gut*, *32*(4), 361-366. http://dx.doi.org/10.1136/gut.32.4.361

Soeparto P, Martosudarmo S, dan Djupri LS. (2003). Sindroma Usus Pendek dan Adaptasi Intestinal. (Makalah), Fakultas Kedokteran RSUD Dr Sutomo, Surabaya, p. 5-11, 14.

Soeparto, P., Djupri, L. S., Sudarmo, S. M., & Ranuh, G. R. (1999). Gangguan absorpsi sekresi, sindroma diare. *Gramik, Surabaya*.

Soewondo, P., Purnamasari, D., Oemardi, M., Waspadji, S., & Soegondo, S. (2010). Prevalence of metabolic syndrome using NCEP/ATP III criteria in Jakarta, Indonesia: the Jakarta primary non-communicable disease risk factors surveillance 2006. *Acta Med Indones*, *42*(4), 199-203.

Ulshen, M. (1996). Clinical manifestations of gastrointestinal disease. *Nelson Textbook of Pediatrics. 15th ed. Philadelphia, Pa: WB Saunders Co*, *1031*.

Van Nieuwenhoven, M. A., Brummer, R. J., & Brouns, F. J. P. H. (2000). Gastrointestinal function during exercise: comparison of water, sports drink, and sports drink with caffeine. *Journal of applied physiology*, *89*(3), 1079-1085. https://doi.org/10.1152/jappl.2000.89.3.1079

Van Praag, H., Kempermann, G., & Gage, F. H. (1999). Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. *Nature neuroscience*, *2*(3), 266. https://doi.org/10.1038/6368

Viru, A. M., Hackney, A. C., Vńlja, E., Karelson, K., Janson, T., & Viru, M. (2001). Influence of prolonged continuous exercise on hormone responses to subsequent exercise in humans. *European journal of applied physiology*, *85*(6), 578-585. https://doi.org/10.1007/s004210100498

Viru, A., & Smirnova, T. (1995). Health promotion and exercise training. *Sports medicine*, *19*(2), 123-136. https://doi.org/10.2165/00007256-199519020-00004

Wideman, L., Weltman, J. Y., Patrie, J. T., Bowers, C. Y., Shah, N., Story, S., ... & Weltman, A. (2000). Synergy of L-arginine and GHRP-2 stimulation of growth hormone in men and women: modulation by exercise. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *279*(4), R1467-R1477. https://doi.org/10.1152/ajpregu.2000.279.4.R1467

Zhou, P., Li, E., Zhu, N., Robertson, J., Nash, T., & Singer, S. M. (2003). Role of interleukin-6 in the control of acute and chronic Giardia lamblia infections in mice. *Infection and immunity*, *71*(3), 1566-1568. https://doi.org/10.1128/IAI.71.3.1566-1568.2003

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Biography of Authors

	Mr. I Nyoman Kanca Curently is a senior lecturer in Sports Science Department of Sports Faculty and chair of the physical education graduate program at Undiksha. I have been working for 30 years. I am very interested in the development of the word sport. *Email: kanca.nyoman@yahoo.co.id*
	Mr. I Ketut Iwan Swadesi Currently is head of Ganesha Sports Center and secretary of the physical education graduate program at Undiksha. My lecturing career has spanned over 20 years. I am very interested and concentrate on developing a sports system in my country. *Email: swadesi2000@yahoo.co.id*
	Mr. I Ketut Yoda Curently is a senior lecturer in Sports Science Department of Sports Faculty Undiksha. I am holding a master's degree in sports science, and doctor of physics education. My lecturing career has spanned over 20 years. I am interested in sports science with special interest in sports education (physical education).
	Mr. Made Agus Wijaya Currently is a lecture at Physical Education, Health and Recreation, Faculty of Sport and Health, Universitas Pendidikan Ganesha, Bali-Indonesia. I hold master and doctor degree in sports education. I am interested to research and community serviced in physical education, sport and health/PESH method, and PESH learning media.