International Journal Of Physical Activity, Nutrition and Health
2023; 1(1), 1-10
URL: https://ijpanh.com/index.php/pub

Research Article **DOI: 10.5281/zenodo.10445606**

Pre-Competition Body Weight, Hydration, and Stress Hormone Changes Among Wrestlers

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Abstract

Reducing pre-competition body weight in wrestlers is a widely used method. However, losing weight fast in a short time influences athletes' hydration levels, electrolyte levels, and stress status negatively. The purpose of the study was to determine wrestlers' pre-competition body weights, hydration and electrolyte levels, and stress hormone changes. The study sample was composed of 24 young male wrestlers. Wrestlers' pre-tests were performed 20 days before the competition and post-tests were performed at competition weighing-time. With tests, wrestlers' body weights and heights were measured. Also, with the help of the specialists, 5 cc. of blood samples were drawn from the forearm veins of the participant wrestlers. According to plasma osmolarity (P_{Osm}) levels of the wrestlers, their hydration status was evaluated. Also, analyses were made for potassium, calcium, chloride, magnesium, and iron electrolyte levels as well as stress hormones such as cortisol, prolactin, total testosterone, and insulin hormone. For the analyses of the data; descriptive statistics and the Wilcoxon Rank test were employed. The correlation between plasma osmolarity and hormones was assessed using the Spearman correlation coefficient. There were significant differences between wrestlers' pre-test and post-test measurements in terms of body weights, plasma osmolarity, cortisol, prolactin, total testosterone, sodium, potassium, chloride, iron, and magnesium values. It was identified that during pre-competition wrestlers' body weights reduced by 3.96% and they became exposed to dehydration, their cortisol and prolactin hormones increased but their total testosterone decreased.

***Keywords**:* Body Weight Loss, Electrolyte, Hydration, Stress Hormones, Plasma Osmolarity

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INTRODUCTION

Wrestlers are classified according to body weights and weight classes. For wrestlers to compete, it is obligatory that their body weights should be consistent with the weight classes they choose at the weighing-time on the day before the competition. But, frequently changing rules and weight classes make athletes' adaptation difficult. However; in the pre-competition period, many athletes reduce their body weight in a short time (1-5 days) using unsuitable methods such as food and fluid restrictions, sauna, and intense exercises so that they can adapt themselves to frequently changing rules and weight classes and have advantages over their rivals by competing in smaller weight classes than their normal body weight (Steen and Brownell 1990; Gibs et al. 2009, Artioli et al. 2010, Yıldırım 2015, Işık et al., 2018; Shirreffs, 2005). Quick changes in body weight in a short time affect wrestlers' hydration levels and subject them to dehydration (loss of fluids) (Shirreffs, 2000). Loss of fluid caused by sweating – particularly- through sauna and intense exercises leads to electrolyte loss. Electrolyte lost by sweating brings mainly sodium (Na) and potassium (K) losses.

Besides, -with loss of fluids- chloride (Cl), magnesium (Mg), iron (Fe) and calcium (Ca) losses occur, too (Sawka et al., 2007; Rehrer, 2001; Demirkan, 2010; Hall, 2015). Electrolytes are electrically charged ions in body fluids. Ions play a role in nerve conduction, muscle contraction, and the production of stimuli necessary for carrying water and other substances into intra-cells and from extra-cells (Born, 1999; Demirkan, 2010; Hall, 2015). With loss of fluids and impaired electrolyte balance (Dehydration); athletes experience such acute cardiovascular disorders as declining plasma volume, deteriorated thermoregulation, arrhythmia, tachycardia, reduced blood pressure, negatively affected distribution of nutrition/energy sources, slow discharge of metabolic wastes, elevated urine density, reduced storage of liver glucose, weakened muscle strength and lower performance (Dorfman, 2011; Choma et al. 1998; Degoutte et al.2006; Coufalova et al. 2013, Hall, 2015; Wilmore and Costill, 2004; Demirkan, 2010). Besides, dehydration also produces negative mood and hormonal changes (Yıldırım, 2015; Degoutte et al 2006). By these hormonal changes, stress hormones (cortisol, prolactin), sex hormones (testosterone), and insulin hormones (a hormone that transforms sugar into energy in the body) are affected (Strauss et al 1985; Roemmich et al. 1997; Anderson et al. 2002; Wilson and Morley 2003; Degoutte et al 2006; Benton 2011; Yıldırım, 2015; Civan et al., 2018).

Being a catabolic hormone, cortisol is secreted from the adrenal cortex. Cortisol influences carbohydrate, protein, and fat metabolism. It increases gluconeogenesis, decreases the use of glucose, and protects glucose sources. Cortisol increases protein catabolism and reduces protein synthesis. Since energy output is transferred to fat, lipolysis increases. Besides, cortisol plays a crucial role in reducing immune resistance against stress and anti-inflammatory effects. Stress raises cortisol secretion perception but there are many hormones whose secretion speed changes with stress. Being one of the hormones affected by these changes, prolactin increases with stress while testosterone decreases (Urban et al., 1995; Griggs et al., 1989; Civan et al., 2018; Widmaier et al., 2011; Yıldırım, 2015). With elevated glucocorticoid as a result of stress, increased prolactin provides T lymphocyte functions and survival. Prolactin inhibits glucocorticoid, a response to stress, and provides immunity resistance in case of stress (Türsen 2011). Unlike prolactin increasing with cortisol, decreased testosterone is affected by cortisol secretion. Testosterone is an anabolic steroid. Testosterone stimulates functional sperm production, the development of the reproduction system, and male secondary sexual growth and growth. Testosterone enhances protein synthesis, stimulates muscle growth, and produces metabolic effects (Urban et al., 1995; Griggs et al., 1989; Civan et al., 2018; Widmaier et al., 2011, Yıldırım, 2015, Hall, 2015). Similar to testosterone, insulin hormone is also affected by cortisol secretion. Insulin hormone protein synthesis, secreted from the pancreas, serves for glucose synthesis, sugar storage, carrying sugar ion and amino acids into cell membranes, and acceleration of fat acids (Hall**,** 2015; Widmaier et al., 2011). As seen literature, fluid and electrolytes are important for cortisol, prolactin, testosterone and insulin hormones, energy metabolism, athlete's health and performance (Born, 1999; Demirkan, 2010; Urban et al., 1995; Griggs et al., 1989; Civan et al., 2018; Widmaier et al., 2011; Yıldırım, 2015; Hoffman, 2014; Di Luigi, 2008, Hall, 2015). In this sense, it is important to explore wrestlers' pre-competition body weights, hydration and electrolyte levels, and stress hormone changes.

It was reported that losing weight in a short time causes a decline in insulin concentration (Degoutte et al. 2006; Rossow et al., 2013; Mäestu et al.,2010), a rise in cortisol concentration (Degoutte et al. 2006, Yıldırım 2015) and a reduce in total testosterone levels (Yıldırım, 2015; Rossow et al.,2013; Mäestu et al.,2010; Hagmar et al.,2013).

When the literature is examined, it is noted that athletes perform fast weight loss in a short time through pre-competition fluid and diet restrictions; which produces negative effects on metabolism and endocrinal parameters, reduces athletes' performance by impairing their physiology and psychology, and exercise-related stress and therefore, testosterone hormone changes are examined (Daly et al. 2005; Brownlee et al. 2005; Degoutte et al.2006; Coufalova et al. 2013; Yıldırım, 2015). In wrestling, one of the sports in which weight classes are used, many changes happen in weight classes and competition rules. In line with these changes, athletes, who participate in competitions, lose weight quickly in a short time using improper methods. We believe that losing weight quickly in a short time influences wrestlers' hydration levels, electrolytes, stress hormones (cortisol, prolactin, and testosterone), and insulin hormones. Actually, Yıldırım (2015) observed a correlation between pre-competition weight losses and dehydration and stress hormones among wrestlers, found that since athletes performed weight loss within 1-5 days, they became subjected to dehydration caused by weight loss and identified a correlation between dehydration and cortisol, prolactin and testosterone levels. However, we have not met any longitudinal studies in the literature that investigated wrestlers' pre-competition body weights, hydration levels, electrolyte levels, and stress hormone changes. Therefore, we argue that it is important to explore wrestlers' sodium, potassium, magnesium, chloride, and calcium electrolyte changes together with their body weights, hydration status, cortisol, prolactin, testosterone, and insulin hormones 20 days before the competition (pre-test) and during pre-competition weighing hour (post-test) using two repetitive measurements. In this sense, the study aimed to determine wrestlers' pre-competition body weights, hydration, electrolyte levels, and stress hormone changes.

METHOD

Participants: The sample of the study consisted of 24 voluntary wrestlers between the ages of 18-30 who joined the camp of the Young Male Free Style Wrestling National Team. All participants provided written consent before the study. Besides, necessary official permissions from the Turkish Wrestling Federation were obtained with protocol number TGF/2261. Additionally, the ethical suitability of the research was approved by the Ethical Council of the Medical Faculty of Afyon Kocatepe University with the decision dated and numbered 2017/3 and 03/03/2017.

Measurements and Tests: Pre-test measurements of the study were taken on the first day of the camp of the national team that started in Afyon Province and post-test measurements were taken 20 days after the pre-test during competition weighing time. With pre-test and post-test, wrestlers' body weights and heights were measured. Also, with the help of the specialists, 5 cc. of fasting blood samples were drawn from the forearm veins of the participant wrestlers. Additionally, survey questions that addressed weight loss methods and questions of information request form (demographic variables) were answered during measurements.

Body Weight and Height Measurements: Wrestlers' heights were measured with barefoot and official jerseys using a Seca stadiometer with 0.01 accuracy. The tare weight of the jersey (250 gr.) was subtracted from body weight.

Biochemical Analyses and Methods: Specialists drew blood samples into the heparin tubes of Vacuetta Greiner. The blood samples were instantly centrifuged with Nuve NF-400 for 10 minutes at 3000 RPM. Plasma samples centrifuged were preserved in Eppendorf tubes and transferred to the laboratory in dry ice. Plasma samples were stored at -85 °C until analysis day. On the day of the analysis; plasma samples were stored at room temperature for 1 hour and dissolved. To analyze hydration markers such as sodium, blood urea nitrogen (BUN) and glucose and calcium, potassium, chloride, iron, and magnesium; the Roche Cobas C501 model biochemical autoanalyzer was used with Roche kits (Roche Diagnostics International Ltd., Rotkreuz, Switzerland). Results were presented in mg/dL for glucose, blood urea nitrogen, calcium, and magnesium; in mEq/L for sodium, potassium and chloride and in µg/dL for iron. Cortisol, insulin, total testosterone, and prolactin were analyzed using Roche Cobas C601 model Hormone autoanalyzer using Roche kits. Results were presented in µg/dL for cortisol, in µU/mL for insulin, and in ng/mL for prolactin and total testosterone.

Experimental Design

Wrestlers' P_{Osm} levels were calculated using the formula of P_{Osm}=(2*NA)+ (BUN/2.8)+ (Glucose/18) (García-Morales et al., 2004, Yıldırım, 2015; Ozkan and Ibrahim, 2016). Those wrestlers whose P_{Osm} was ≤290 composed the euhydration group while those wresters whose P_{Osm} was >290 composed the dehydration group (Popowski et al. 2001; Cheuvront et al. 2010; Yıldırım, 2015).

Statistical Analysis

Data were processed with the SPSS program. The normality test of the data was analyzed with the Shapiro-Wilk test. To analyze the data that did not follow a normal distribution, descriptive statistics, and the Wilcoxon Rank test were employed. The correlation between plasma osmolarity and hormones was calculated using the Spearman correlation coefficient in relation with post-test results. Results were considered significant at $p<0.05$. Percentage differences in measuring time were found with %Δ= [(Pre-test-Post-test)/ Pre-test*100] formula.

FINDINGS

Table 1. Descriptive Statistics

Variables	Time	Mean±Sd.	Reference range
Cortisol (µg/dL)	Pre-test	11.31±4.86	4.30-22.40
	Post-test	14.85±7.75	
Insulin (µU/mL)	Pre-test	11.17±5.33	2.6-24.9
	Post-test	19.06±21.60	
Prolactin (ng/mL)	Pre-test	24.32±6.33	4.04-15.2
	Post-test	21.85±16.00	
Total Testosterone (ng/dL)	Pre-test	638.05±177.27	286-800
	Post-test	412.49±175.22	
Glucose (mg/dL)	Pre-test	88.82±4.20	74-106
	Post-test	107.44±21.80	
BUN (mg/dL)	Pre-test	13.3±2.29	7.9-21
	Post-test	17.77±4.21	
Calcium (mg/dL)	Pre-test	9.98±.36	8.6-10.2
	Post-test	10.81±0.63	
Sodium (mEq/L)	Pre-test	139.79±1.28	136-145
	Post-test	148.75±5.74	
Potassium(mEq/L)	Pre-test	4.67±0.39	3.5-5.1
	Post-test	4.42±0.49	
Chloride (mEq/L)	Pre-test	99.83±2.97	98-107
	Post-test	103.47±5.37	
Iron (µg/dL)	Pre-test	79.83±25.59	70-180
	Post-test	110.74±30.76	
Magnesium (mg/dL)	Pre-test	2.19±0.12	1.6-2.6
	Post-test	2.28±0.18	
P_{Osm} (mOsm/L)	Pre-test	289.27±2.60	≤290
	Post-test	309.82±12.09	
Body weight (kg)	Pre-test	82.85±20.02	—

	Post-test	79.75±20.30

Table 2. Comparison of wrestlers' biochemical and hormonal measurements

Variables	Difference of Times	Ranks	Mean Rank	z	p	%Δ
Cortisol	Pre- Post	Negative Ranks	10.17	-2.543	0.011*	39.76
		Positive Rank	13.28			
Insulin	Pre- Post	Negative Ranks	8.29	-1.443	0.149	-
		Positive Rank	16.71			
Prolactin	Pre- Post	Negative Ranks	12.21	-2.343	0.019*	-11.65
		Positive Rank	13.60			
Total Testosterone	Pre- Post	Negative Ranks	13.19	-3.629	0.001**	-31.54
		Positive Rank	7.67			
Glucose	Pre- Post	Negative Ranks	5.33	-3.829	0.001**	20.88
		Positive Rank	13.52			
BUN	Pre- Post	Negative Ranks	5.00	-3.571	0.001**	37.42
		Positive Rank	14.47			
Calcium	Pre- Post	Negative Ranks	4.50	-4.029	0.001**	8.44
		Positive Rank	13.23			
Sodium	Pre- Post	Negative Ranks	0.00	-4.289	0.001**	6.41
		Positive Rank	12.50			
Potassium	Pre- Post	Negative Ranks	13.59	-2.315	0.021*	-4.96
		Positive Rank	9.86			
Chloride	Pre- Post	Negative Ranks	4.00	-3.711	0.001**	3.61
		Positive Rank	13.68			
Iron	Pre- Post	Negative Ranks	6.58	-3.157	0.002**	52.66
		Positive Rank	14.47			
Magnesium	Pre- Post	Negative Ranks	7.17	-2.445	0.014*	4.15
		Positive Rank	15.70			
P_{Osm}	Pre- Post	Negative Ranks	0.00	-4.286	0.001**	7.11
		Positive Rank	12.50			
Bady weight	Pre- Post	Negative Ranks	13.67	-3.915	0.001**	-3.96
		Positive Rank	4.33			

*p<0.05; **p<0.001

According to the results of the study, it was noted that there were significant differences between wrestlers' pre-test and post-test measurements in terms of body weights, plasma osmolarity, cortisol, prolactin, total testosterone, sodium, potassium, chloride, calcium, iron and magnesium values (Table 2).

Table 3. Correlation between hydration level and stress hormone

Variables	Cortisol	Insulin	Prolactin	Total Testosterone
Insulin	-0.421*			
Prolactin	0.257	-0.465*		
Total Testosterone	-0.494*	0.004	-0.150	
P_{Osm}	0.591**	-0.141	0.175	-0.650**

*p<0.05; **p<0.001

According to correlation results, it was identified that there was a positive correlation between plasma osmolarity and cortisol but a negative correlation between plasma osmolarity and total testosterone. Besides, a negative correlation was found between cortisol and total testosterone and insulin (Table 3).

DISCUSSION

Frequently changing rules and weight classes in such combat sports as judo, karate, taekwondo, and wrestling make athlete adaptation difficult. Therefore, athletes perform fast weight loss in a short time during pre-competition but it is reported that weekly weight loss should not exceed 1.5% (Utter, 2001). In the current study, it was found that wrestlers lost body weight by 3.96% in a short time in the pre-competition period (1-5 days) (Table 1,2). According to the results of the current study, which were similar to other studies in the literature (Yıldırım, 2015; Artioli et al. 2010; Lambert and Jones 2010; Demirhan 2012; Coufalova et al. 2013); it was identified that athletes' weekly weight loss was more than 1.5%. Athletes said that they performed weight loss mainly through food and fluid restrictions and partly through exercises. With our hypothesis, we emphasized previously that sudden changes occurring in wrestlers' body weights in a short time affect hydration levels negatively. Actually, according to our study results, our hypothesis was verified and wrestlers' plasma osmolarity differed significantly and wrestlers became subjected to dehydration according to results of the pre-test ($P_{Osm}<290$) and post-test ($P_{Osm}>290$) repeated in 20 days (Table1,2). In literature, athletes whose P_{Osm} is ≤290 are considered as in euhydrated condition while other athletes whose P_{Osm} is >290 are considered as in dehydrated condition (Popowski et al. 2001; Cheuvront et al. 2010, Yıldırım, 2015). According to this reference range, wrestlers were in euhydrated condition in pre-test results but in post-test results, they were in dehydrated condition (Table 1).

It was thought that fast weight losses obtained in a short time would affect negatively not only hydration levels but also electrolytes, stress hormones (cortisol, prolactin, testosterone), and insulin hormones and thus, calcium, sodium, potassium, chloride, iron and magnesium values of wrestler who experienced weight loss and dehydration differed according to pre-test and post-test results (Table 1,2). It was seen that wrestlers' sodium rate went up in the post-test and it may be argued that wrestlers' sodium rate might have gone up due to dehydration caused by loss of fluids and loss of fluids might have increased sodium concentration. The first electrolyte that is affected by high sodium levels due to dehydration is potassium. High levels of sodium results in potassium excretion (Sawka et al., 2007; Rehrer, 2001; Demirkan, 2010). In this current study, sodium rose but potassium declined in post-test. It was seen that wrestlers' calcium, chloride, iron, and magnesium electrolytes increased in the post-test as compared to the pre-test. We think that there may be two reasons for this finding. One reason was that body weight loss mainly occurred due to food and fluid restrictions and water excretion through sweating was lower. Thus, the body weight loss resulted from water excretion, but mineral losses did not occur and as a result of fluids lost, mineral concentration in the body elevated. Another reason was that since athletes were at the camp of the national team, nutritionists may have taken necessary measures and provided necessary vitamin and mineral supplements; as a result, electrolytes were not affected by the loss of fluids; on the contrary –for us- electrolytes elevated. One of the most important hypotheses in this study was that there would be differences not only in stress hormones (cortisol, prolactin, testosterone) but also in insulin hormones due to dehydration caused by fast weight loss in a short time. It was found that wrestlers were in euhydrated condition in pre-test results whereas in post-test results they experienced weight losses and were subjected to dehydration due to hydration levels negatively affected, their cortisol and prolactin hormone levels increased but total testosterone levels reduced. No significant difference was seen in insulin hormone (Table 1,2). We believe that post-test changes in cortisol, prolactin, and total testosterone hormones occurred due to dehydration. In this sense; when post-test correlation results were investigated, it was noted that there was a positive correlation between plasma osmolarity and cortisol but a negative correlation between plasma osmolarity and total testosterone. Also, it was identified that there was a negative correlation between cortisol, total testosterone, and insulin (Table 3). The literature argues that cortisol and low carbohydrate intake are correlated, and carbohydrate loading reduces cortisol (Anderson et al., 1991). Besides, it is suggested that weight losses obtained through short-term food and fluid restriction will bring increased cortisol levels, tensions, and anger and therefore will reduce performance (Hall and Lane 2001, Anderson et al. 2002; Degoutte et al 2006; Yıldırım, 2015). According to post-test results, as plasma osmolarity climbed up, so did cortisol and prolactin but a decrease in total testosterone might be correlated with dehydration as well as cortisol. Some studies determined that diet and fluid restriction reduced total testosterone levels and there was a correlation between total testosterone values and body fat percentage, body fat loss, and body weight loss (Strauss et al 1985; Roemmich et al. 1997; Degoutte et al. 2006). In the study of Yıldırım (2015), a negative correlation was detected between hydration levels and total testosterone levels. According to post-test results, another reason for the decrease in total testosterone may be explained by elevated cortisol levels because it may be argued in the current study and other studies that cortisol is negatively correlated with total testosterone (Cumming et al. 1983; Hackney et al. 1989; Brownlee et al. 2005; Daly et al. 2005, Yıldırım, 2015). Meanwhile, in some studies, it was stated that cortisol decreased circulating total testosterone by suppressing it (Hackney and Dobridge 2003; Daly et al. 2005, Yıldırım, 2015). Similar to total testosterone; insulin hormone was also influenced by cortisol secretion and it was noted that as cortisol increased insulin hormone levels decreased. Some studies about energy restriction identified a decrease in insulin hormones (Rossow et al.,2013; Mäestu et al.,2010) and testosterone hormones (Rossow et al.,2013; Mäestu et al.,2010; Hagmar et al.,2013) but an increase in cortisol hormones (Rossow et al.,2013; Witbracht et al.,2012; Tomiyama et al.,2010). In the study of Degoutte et al. (2006), it was reported that fast weight losses led to a reduction in insulin concentration while a rise in cortisol concentration. The correlation between cortisol and insulin is important in energy balance and may be deteriorated by chronic stress. Glucocorticoids show diabetogenic effects by interfering with insulin effects in various degrees (Rosmond,2003; Dallman, Strack, Bradbury, Scribner, Smith, 1993). Cortisol directly blocks insulin secretion from pancreatic B-cells and finally results in insulin resistance (Lambillotte, Gilon, and Henquin, 1997). Maintaining blood glucose plays a key role in reducing immune system changes mediated by increases in stress hormones (in particular cortisol) and cytokines (Plowman and Smith, 2013). In this current study, it was detected that blood glucose was elevated. This research was limited to changes in body weight, hydration status, and stress hormones depending on the wrestlers' weight loss at the beginning and end of the 20-day camp (competition weigh-in time) before an official competition. In future studies, it should be tested whether athletes can regulate the level of these physical and physiological parameters before hydration, in the period between the competition weigh-in time and the competition time (2 hours). Thus, researchers can reveal whether the physical and physiological harms of losing weight in wrestlers continue during the competition time, even though they stop dehydration.

In sum; in this longitudinal study it was found that there were significant differences between wrestlers' pre-test and post-test measurements in terms of body weights, plasma osmolarity, cortisol, prolactin, total testosterone, sodium, potassium, chloride, iron, and magnesium values. It was identified that wrestlers' pre-competition body weights were reduced by 3.96% and they became subjected to dehydration, their cortisol and prolactin hormones increased but their total testosterone decreased. In this sense, coaches and sports psychologists should take necessary measures and undertake necessary studies so that wrestlers can adapt themselves to frequently changing rules and weight classes. Besides, it is important that prospective longitudinal studies examine stress hormones in relation to changes in hydration levels by supporting athletes with ergogenic aids during the pre-competition period.

Authors' Statement of Contribution to the Article

Idea/Concept: İrfan Yıldırım, Özkan Işık; Article design: İrfan Yıldırım, Özkan Işık, Halit Buğra Koca; Consulting: İrfan Yıldırım; Data Collection and Processing: İrfan Yıldırım, Özkan Işık, Şeniz Karagöz, Rıfat Yağmur; Analysis/Comment: İrfan Yıldırım, Halit Buğra Koca, Özkan Işık; Literature review: İrfan Yıldırım, Halit Buğra Koca, Özkan Işık; Article writing: İrfan Yıldırım, Halit Buğra Koca, Özkan Işık; Critical Analysis: İrfan Yıldırım, Halit Buğra Koca, Özkan Işık; Source/Material: İrfan Yıldırım, Özkan Işık, Şeniz Karagöz, Rıfat Yağmur; Article Submission Corresponding Author: Halit Bugra Koca.

Conflict of Interest

The authors have no conflict of interest to declare.

Financial support

This study would not have been possible without the financial support of the Afyon Kocatepe University Scientific Research Project Unit and was supported within the scope of project number 16.BESYO.01.

Ethics Committee Approval

This study is in line with the Declaration of Helsinki. Ethics Committee. The approval report was obtained for the study with the decision of the Afyon Kocatepe University Clinical Research Ethics Committee dated 03.03.2017 and numbered 2017/3.

Peer Review

After the blind review process, it was found suitable for publication and accepted.

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