EVALUATION OF THE PSYCHOLOGICAL AND HORMONAL PARAMETERS IN PARAGLIDING

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Abstract **Background.** Paragliding is an extreme sport performed by gliding from a mountain at high altitude into the air. The authors aimed to determine the differences between the levels of adrenaline, cortisol, and insulin before and after the flight of tandem pilots and passengers flying for the first time, and to determine the relationship between these hormones and death anxiety and risk-taking levels.

Materials and methods. The study included 12 experienced male pilots and 15 male passengers flying for the first time. Heart rate and blood pressure were measured after the participants had filled in Personal Information Form, DOSPERT Risk-Taking Scale and Death Anxiety Scale before the flight. Blood samples were taken before and after the flight to determine adrenaline, cortisol, and insulin levels.

Results. Adrenaline and cortisol levels, as well as heart rate, increased significantly after the flight, while insulin levels decreased significantly in the passenger group ($p < 0.05$). There were no statistically significant differences in the pilot group.

Conclusions. The experience factor plays an important role in the positive effect of paragliding flight on cortisol, adrenaline, insulin, and various physiological parameters, as well as mediates the adaptation of the organism to unusual situations. The human organism adapts physiologically and hormonally to the flying action. One of the striking results of the study was that cortisol levels were at the upper limit of normal values in the passenger group after the flight.

Key words paragliding, hormones, risk, anxiety

Introduction

Paragliding is a non-motorized air vehicle and also a sport performed with this vehicle, which is executed by gliding from a hill or mountain at high altitude into the air (Goksal, 2019; TAA, 1996). It is an air-based, fun, adventure-style, recreational and competitive sport, which can be performed single or in tandem (Mekinc, Music, 2016; Canbek, İmerci, Akgün, Yeşil, Aydin, Balci2015; Laver, Mei-Dan, 2013). Extreme sports have gained importance not only for adventurous elite athletes but also as a form of recreation for individuals. There is an increasing appeal to a wider audience, with the growing popularity of adventure sports and high-risk activities in the natural environment worldwide (Tordjman, Constantini, Hackney, 2013; Paixăo, Tucher, 2012). In recent years, since high altitude situations and sports have attracted wider attention, participation in paragliding, which is an extreme, adventure-style air sports branch, has become increasingly popular worldwide. Consequently, understanding the psychological and physiological effects of paragliding activities has gained importance for healthcare and sports science researchers (Yalcin, Kardesoglu, Isilak, 2011; Paixăo, Tucher, 2012).

In stress situations, the sympathetic nervous system and adrenal medulla act together. Factors that stimulate the sympathetic nervous system and adrenal medulla include emotional and physical stimuli, such as physical activity, cold, hypoglycemia, fear, anxiety, and excitement. These stimuli are also involved in paragliding. In such cases, catecholamines play an important role in the formation of reactions that allow the body to adapt to abnormal conditions (Onat, Kaya, Sozmen, 2002). Each flight causes stress, and hormones such as adrenaline, cortisol, and insulin are released by acute stress. These hormonal responses stimulate glycogenolysis and fatty acid oxidation to provide the required amounts of energy for cellular activity under stress (Onat et al., 2002; Hackney, 2006). Insulin acts on most tissues, leading to a decrease in blood glucose levels by different mechanisms (Bakan, Tek, 2018).

There are numerous studies in the literature, as extreme sports contain high-risk situations and there is an interest in risk-taking behaviors and reasons for them. C. Castanier, C.L. Scanff and T. Woodman (2010) conducted typological research on those taking risks in high-risk sports including paragliding, and a study by A. Agilonu, G. Bastug, T.O. Mutlu and A. Pala (2017) was conducted to examine the fields of sensation seeking and risk-taking behavior in extreme sports. Participation in extreme nature sports is believed to be motivated by the desire to take risks, the need for excitement and pleasure, and paragliding in nature has been shown to create positive effects on individuals and positive psychological effects between individuals and nature (Ozciris, 2017; Şimşek, 2010; Brymer, Oades, 2009). Paragliding is an extreme and risk-bearing sport, but the risks are – to an extent – dependant on the pilot (Schulze, Richter, Schulze, Esenwein, Büttner-Janz, 2002). Paragliding exposes its participants to different life-risks due to its adventurous and extreme nature. The limit between the calculated or predicted risk and the actual risk is a thin boundary that depends on the pilot's perception. When considering the risk in paragliding sports, the most extreme challenge faced by practitioners is to be aware of the definition and effects of the risk (Paixăo, Tucher, 2012). Risk-taking behavior is defined as including possible negative consequences (losses) but is perceived with some positive results (acquisitions) (Moore, Gullone, 1996). High-risk sports may result in a fault, an accident or death risk (Brymer, Oades, 2009). Death anxiety is defined as thoughts, fear and emotions about the last event or moment of life in the individual's mind (Belsky, 1999; Sarıkaya, 2013). Even if participants acknowledge that a possible outcome of a failure or an accident results in death, accepting this potential result does not imply that they are seeking risks (Brymer, 2010). Risk-taking and death anxiety in its participants are two significant issues within the integrated structure of paragliding.

Research studies examining hormonal responses to extreme sports and the relationship of these responses to psychological conditions are very few and limited. The aim of this study was to investigate the relationship between death anxiety and risk-taking levels, adrenaline, cortisol, insulin, heart rate, and blood pressure parameters of paragliding tandem pilots and individuals flying for the first time and the effect of experience on these parameters.

Materials and Methods

Study design

The study included 12 male professional paragliding tandem pilots and 15 male passengers flying for the first time in Ölüdeniz, Turkey. The tandem pilots were matched with passengers according to weight limits. The age, weight, and flight time experience data were recorded for each participant on a Personal Information Form. To determine the risk-taking level, the DOSPERT Risk-Taking Scale and Death Anxiety Scale (DAS) were completed by the participants. The DOSPERT Risk-Taking Scale is a 7-point Likert scale, which measures risk-taking behaviors in individuals and evaluates the individuals in terms of moral, social, health, entertainment, and financial fields (Blais, Weber, 2006). The Turkish Death Anxiety Scale was prepared with responses to items in a 5-point Likert form. The total points range from 0 to 80, with higher points indicating a higher level of death anxiety. The scale measures the death anxiety from the point of the uncertainty of death, exposing, and suffering factors (Sarıkaya, Baloglu, 2016). The language of the scales is presented in Turkish.

All the pilots took off from the designated airstrip at 1,700 meters' altitude and completed a 30-minute flight. When the pilots were over the sea, they performed, on average, 4–5 times Wingover and 5–6 times spiral. All the flights were performed in groups at 10:30, 12:00, 14:00 and 15:30 on the same day and similar weather conditions. The wind limit was 5–10 mph.

The Clinical Research Ethical Board of Muğla Sıtkı Koçman University reviewed and approved this study (9.08.2018–13.08.2018). This study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from all individual participants before their inclusion in the study.

Measurements

To measure the physiological parameters, the systolic-diastolic blood pressure values, and heart rate per minute of the pilots and passengers were measured using a digital sphygmomanometer with the subject in the sitting position, two hours before the flight, and at post-flight at the time of the release of the parachute harness on landing. After overnight fasting, venous blood samples were collected from the antecubital vein into gel-separated blood tubes by venipuncture before and after the flight. The gel-separated blood tubes were left at room temperature for 10–20 min for separation of serum followed by centrifugation at 2,000 × g for 10 min. Serums were aliquoted and stored at –80 degrees Celsius until analysis. The blood samples were collected before the flights between 8:30 and 9:00 am to avoid the diurnal variability of cortisol levels. The post-flight blood samples were collected within 10 minutes after the landing.

Serum adrenaline levels were measured using the Human Epinephrine/Adrenaline (EPI) enzyme-linked immunosorbent assay (ELISA) kit (YLbiont, YL Biotech Co., Ltd, Shanghai, China; Cat. No: YLA 0837HU). Measurements were performed at Bio-Tek Synergy HT (Biotek Instruments Inc. Winooski, VT, USA) ELISA plate reader at 450 nm. Intra and inter-assay repeatability (CV) values of the ELISA kit are <8% and <10%, the measurement range is 5–1,000 ng/L and the sensitivity level is 2.49 ng/L.

Cortisol and Insulin levels were measured by Electrochemiluminescence Immunoassay (ECLIA) method by using the commercial kits of Access Ultrasensitive Insulin (Cat. No. 33410) and Access Cortisol (Cat. No. 33600) (Beckman Coulter, Brea, CA, USA) on the UniCel DXI 800 Access Immunoassay analyzer.

Statistical analysis

Statistical calculations were made in SPSS (version 18.0) program. The Shapiro-Wilk test was used to evaluate the distribution of variances. Variables with normal distribution were presented as mean ±SD and non-normally distributed variables were presented as median and quartiles (25–75th percentiles). The paired t-test and Wilcoxon Signed Rank test were used to compare the pre-test results with the post-test results of the passenger and pilot groups. Independent sample t-test and Mann Whitney U test were used in the comparison of pre-tests of the passenger and pilot groups. The relationship between the variables was analyzed with the Spearman correlation test. Cohen d values were taken into account in determining the effect size on the hormone values (adrenaline, cortisol, and insulin) and physiological variables (heart rate, blood pressure) of the flight program applied to the passenger group. The significance level was accepted as $p < 0.05$.

Results

The 12 subjects in the pilot group were a mean age of 33.1 ±7.9 years, bodyweight of 73.6 ±8.1 kg, paragliding experience of 12.0 ±6.9 years, and tandem experience of 7.2 ±4.9 years. The 12 subjects in the passenger group were a mean age of 30.7 ±5.0 years and bodyweight of 80.0 ±10.1 kg. No statistically significant difference was found between the pilot and passenger groups with respect to demographic data (Table 1).

Table 1. Descriptive statistics of passengers and pilots

	Passengers	Pilots	p
Subjects (n)	15	12	
Age in years	31 ±5	33 ±8	0.305
Experience in years	–	10 (7, 13)	–
Weight in kg	80 ±1	74 ±8	0.076
DOSPERT score	115 ±15	112 ±35	0.781
DAS score	14 (11, 33)	12 (4, 20)	0.442

Data are presented as mean ±SD for normally distributed variables and as median and quartiles (25th, 75th percentiles) for non-normally distributed variables. DAS: death anxiety scale.

In the passenger group post-flight, adrenaline ($Z = –2.955$, $p = 0.003$), cortisol ($t(14) = –4.182$, $p < 0.001$) and insulin concentrations ($t(14) = 2.280$, $p = 0.039$) and heart rate ($t(14) = –4.802$, $p < 0.001$) values were statistically different from the pre-test values (Table 2; Figure 1). Adrenaline and cortisol concentrations and heart rate increased significantly, while insulin concentrations decreased significantly after the flight. The effect of the flight on the adrenaline and insulin concentrations of the passenger group was moderate, and the effect of the flight on cortisol and heart rate was strong. No significant difference was found in other variables.

There were no differences in the pilot group between pre- and post-flight adrenaline, cortisol and insulin concentrations, and the heart rate and blood pressure (systolic and diastolic) levels (Table 2, Figure 1).

When the sub-dimensions and total scores of the death anxiety and risk-taking scales of the passenger and pilot groups were compared, no statistically significant differences were determined (Table 1).

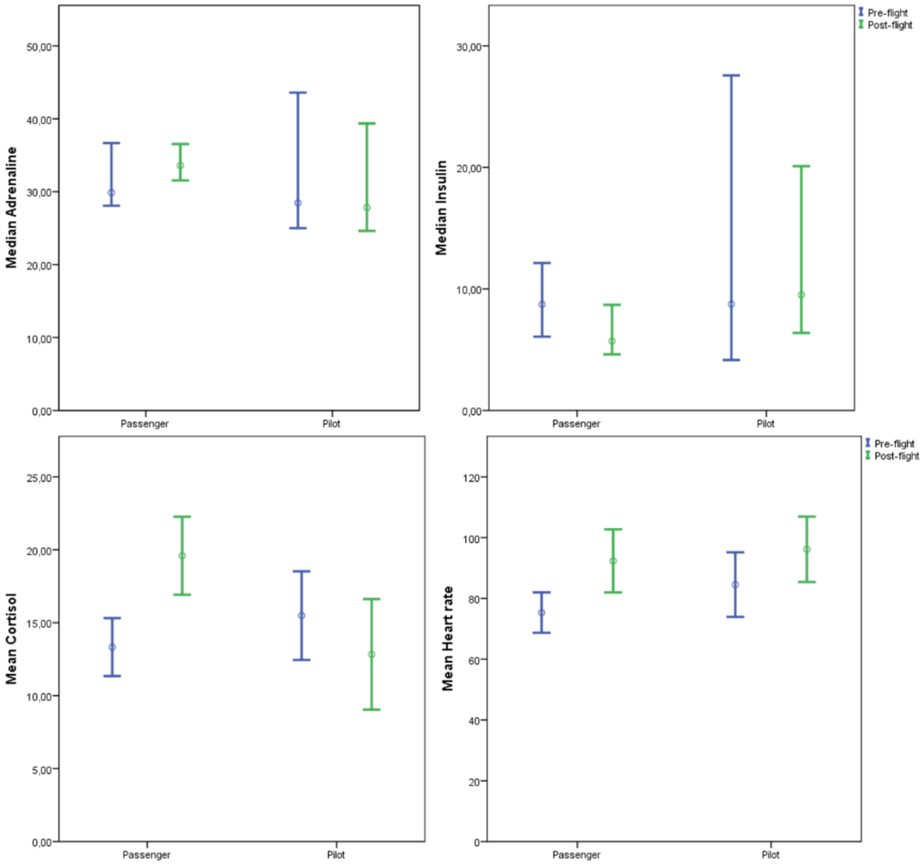

Figure 1. Error bar graphs at the 95% confidence interval (95% CI) of adrenalin, insulin, cortisol, and heart rate

Table 2. Results at pre-flight and post-flight between passengers and pilots

	Passengers			Pilots	
	Pre-flight	Post-flight	Cohen d	Pre-flight	Post-flight
Subjects (n)	15	15		12	12
Adrenaline (ng/L)	[a] 29.87 (28.08, 36.67)	[a] 33.59 (31.54, 36.54)	0.76	28.46 (28.08, 33.46)	27.82 (24.75, 35.26)
Cortisol (ug/dL)	[b] 13.32 ±3.58	[b] 19.59 ±4.83	1.07	15.13 ±5.08	11.57 ±4.54
Insulin (uIU/mL)	[a] 8.73 (6.07, 12.13)	[a] 5.71 (4.61, 8.69)	0.58	8.75 (4.86, 15.77)	9.51 (7.10, 19.92)
Heart rate (pulse/min)	[b] 75.33 ±12.01	[b] 92.33 ±18.73	1.23	84.91 ±18.32	95.50 ±18.41
SBP (mmHg)	129.66 ±8.59	121.00 ±21.72		123.83 ±19.9	133.33 ±14.89
DBP (mmHg)	81.60 ±7.54	86.33 ±20.08		83.00 ±9.04	82.91 ±11.57

Data are presented as mean±SD for normally distributed variables and as median and quartiles (25th, 75th percentiles) for non-normally distributed variables. SBP: Systolic blood pressure, DBP: Diastolic blood pressure.
[a] Indicating statistically significant differences between groups with Wilcoxon Signed Rank test.
[b] Indicating statistically significant differences between groups with Paired t-test.

No statistically significant correlation was found between the variables (Table 3).

Table 3. Correlation of adrenaline, cortisol, insulin, heart rate, and scale scores of the passenger group after the flight

		1	2	3	4	5	6
Adrenaline (1)	r		0.206	–0.250	0.357	0.292	0.211
	p		0.462	0.368	0.192	0.291	0.450
	n		15	15	15	15	15
Cortisol (2)	r	0.206		–0.154	–0.081	–0.102	0.250
	p	0.462		0.585	0.775	0.717	0.368
	n	15		15	15	15	15
Insulin (3)	r	–0.250	–0.154		0.286	–0.199	–0.332
	p	0.368	0.585		0.301	0.477	0.226
	n	15	15		15	15	15
Heart rate (4)	r	0.357	–0.081	0.286		0.367	–0.433
	p	0.192	0.775	0.301		0.179	0.107
	n	15	15	15		15	15
Death anxiety total score (5)	r	0.292	–0.102	–0.199	0.367		–0.162
	p	0.291	0.717	0.477	0.179		0.565
	n	15	15	15	15		15
Risk taking total score (6)	r	–0.211	0.250	–0.332	–0.433	–0.162	
	p	0.450	0.368	0.226	0.107	0.565	
	n	15	15	15	15	15	

Discussion

A major finding of our study was that passengers without any experience in paragliding had more hormonal changes than tandem pilots.

In a previous study, the change of saliva cortisol, a stress-related hormone, was analyzed according to gender in paragliding, and it was reported that the level of saliva cortisol in paragliding tends to increase gradually before take-off, during flight, and during landing, and experienced people and females have fewer stress factors related to paragliding (Choi, Kim, 2013). In another study investigating the post-stress variations of elite paragliders, the Telic Dominance Scale and CSAI-2 scales were used, and stress and cortisol responses in pre- and post-paragliding competition of 10 paragliding competitors were examined. The cognitive anxiety and cortisol responses of the participants were reported to be significantly high (Filaire, Rouveix, Alix, Le Scanff, 2007). In our study, the pre-flight cortisol level of experienced paragliding tandem pilots was lower than that of individuals who were taking tandem flights for the first time. Consistent with this literature, the findings of our study showed that the post-flight cortisol level was higher than the pre-flight level and this difference was statistically significant in the passenger group ($p < 0.05$).

Another study examined state anxiety and cortisol release in 11 novices and 13 experienced skydivers on completion of a skydive. Although higher levels of state anxiety have been reported in novice paratroopers before jumping, no difference was found in the pre-jump levels of cortisol examined in the saliva samples. Significantly higher levels of saliva cortisol were observed in both groups in the samples taken in immediately after the jump compared to the pre-jump values. However, it was stated that the two groups were indistinguishable in terms of cortisol reactivity to the skydive. These findings indicate that skydiving led to acute cortisol activation. It has also been stated that cortisol reactivity is not habitual in experienced jumpers. These findings support the results of previous studies showing that skydiving revealed acute cortisol activation (Hare, Wetherell, Smith, 2013). In contrast, the results of our study showed differences in cortisol hormone levels and rate between experienced pilots and those flying for the first time. However, in the analysis within each group of the pre and post-flight values, there was no considerable difference among the experienced pilots. Thus, it can be said that cortisol responses to a 30-minute paragliding flight among experienced pilots cause hormonal adaptation. In the paragliding flight with the same criteria, the response level of the pilot's cortisol hormone is different.

According to the results of this study, no statistically significant difference was determined between the pilot and passenger groups in respect of the pre-flight adrenaline, cortisol and insulin hormone, and the heart rate and blood pressure (systolic and diastolic) values. This indicated that both groups were in the same conditions pre-flight. The effect size of the flight on the adrenaline and insulin hormone levels of the passenger group was observed to be moderate, and the effect size on cortisol hormone and heart rate was strong. Data collection for the research was carried out during the active paragliding flight season. During the day, adrenaline, cortisol, and insulin hormone values of tandem pilots were within normal limits with heart rates and blood pressure values. This demonstrated that the bodies of the pilots had adapted to the stress and less hormone was released against the workload that the flight places on the body.

It has been stated that there is a decrease in the hormonal stress response given to exercise as a result of adaptation to the continuity of exercise in the neuroendocrine system and in some cases, a decrease in basal hormone levels in adults (Hackney, 2006). Trained individuals have been shown to have lower responses than sedentary individuals exercising with an equal workload (Koz, Ersoz, Babul, 1997). Based on these results, it can be said that pilots use these hormones more economically against stress and exercise than those who were flying for the first time.

When the sub-dimensions and total scores of the death anxiety scale of the passenger and pilot groups were compared, no statistically significant difference was found. The average death anxiety level of both the passenger and pilot groups was low. The average total score was 20 in the passenger group, and 15.7 in the pilot group, and both of these scores indicate low death anxiety. In the passenger group, no correlation was determined between the adrenaline, cortisol, and insulin levels after the flight and the heart rate, fear of death, and risk-taking levels.

No significant correlation was found between the death anxiety and risk-taking scale results of the paragliding pilots and passenger groups with adrenaline, cortisol, insulin hormones, heart rate, and pulse pressure values. When the correlation between death anxiety and risk-taking scale results applied to the pilot and passenger groups before the paragliding flight was not taken into consideration, no significant difference was observed between the two groups. The reason for the lack of significant difference between passenger and pilot group scores in the death anxiety and risk-taking scale results may be due to the suppression of the anxiety of the passenger group. Passengers' anxiety may be low due to professional flight conditions, because, significant differences were observed in the stress hormones and physiological measurements of the passenger group compared to the pilots. What is more, significant differences were observed in these parameters before and after the flight. A similar situation was examined in a research conducted by Z.S. Çakır (2010) on free paratroopers; only one measurement correlation was found in the correlation of the state anxiety scale results of the paratroopers and the heart rate values taken during the flight phases.

Conclusions

The results showed that the passengers flying for the first time had significantly different hormonal responses to flying than professionals. Moreover, passenger post-flight insulin and adrenaline levels were within the normal reference value ranges, whereas the cortisol levels reached upper reference values, which was a surprising result of the study. Adrenaline, cortisol, and insulin levels of the pilot group did not change after the flight. Limitations of the study were the relatively low number of participants and that the heart rate of the participants was not measured during the flight.

In the study, it was thought that adrenaline and other parameters could peak at the time of takeoff and wingover and spiral maneuvers. However, the blood sample was not taken at this point as it may pose a health hazard at the time of exit. Landing planning was made immediately after the wingover and spiral maneuver to approach the peak values of the parameters in flight. And the data was received immediately.

It can be inferred that experience in paragliding plays an important role in the positive effect of cortisol, adrenaline, insulin hormone, and physiological parameters, and the human organism provides physiological and hormonal adaptation to the flight. Before and immediately after the flight, when stress hormones and physiological parameters were examined, tandem paragliding flight had no negative effect on health for individuals with no health problems. Continuous paragliding flight can ensure that the reactions occurring in the active hormones and physiological parameters that occur before, during, and after the flight adapt to fly.

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