ORIGINAL ARTICLE

Stress levels among winter swimmers, firefighters, martial arts athletes in Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia and Spain

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C Statistical Analysis
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Abstract

Background & Study Aims: Pro-health behaviours may have the form of habits and goal-oriented activities. The first are mainly shaped by social influence and have the form of long-term patterns of automatized behaviours (e.g., bodily hygiene, eating habits). On the other hand, goal-oriented activities are shaped during the course of individual development and the self-creation of one's lifestyle. The aim of the current study was knowledge about stress levels between winter swimmers and martial arts athletes (pro-health behaviours) on the one hand, firefighters and non-athletes having a sedentary behaviour (anti-health behaviours) on the other.

Material & Methods: The study was carried out in Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia and Spain. A total of 542 individuals participated, including 72 winter swimmers, 358 martial arts athletes, 49 professional firefighters, and 63 non-athletes. The Perception of Stress Questionnaire by M. Plopa and R. Makarowski (2010) was used to measure emotional tension, external stress, and intrapsychic stress.

Results: From among the 11 samples, the highest total stress levels and external stress levels were reported by firefighters. The lowest levels of external and intrapsychic stress were reported by winter swimmers, while the lowest levels of emotional tension were reported by Lithuanian martial arts athletes. The lowest total stress levels were reported by winter swimmers and Lithuanian martial arts athletes. Male martial arts athletes from Italy, Latvia, Lithuania, Poland, Romania and Slovakia reported higher stress levels than female athletes.

Conclusions: Physical fitness alone, possessed by professional firefighters, is an insufficient buffer against stress, in contrast to winter swimmers. Pro-health behaviours, that is, training in martial arts and winter swimming, lowers external stress, intrapsychic stress, and emotional tension. If conditions permit it, winter swimming together with training in martial arts may lower stress.

Keywords: emotional tension • external stress • intrapsychic stress • pro-health behaviours

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INTRODUCTION

It is commonly held that sports are beneficial for health [1, 2]. Pro-health behaviours may have the form of habits and goal-oriented activities. The first are mainly shaped by social influence and have the form of long-term patterns of automatized behaviours (e.g., bodily hygiene, eating habits). On the other hand, goal-oriented activities are shaped during the course of individual development and the self-creation of one's lifestyle. Sports or physical activity may be one such activity [3]. Fun forms of martial arts, music therapy with martial arts, honourable self-defence could, also, be used, as pro-health behaviours, and as prophylactic means for violence and for the recently appeared – virtual violence (cyberbullying) [4], while *health qigong* and *yi jin jing* (including breathing, physical activity and psychological adjustment) have important fitness effects on common chronic diseases [5].

In the CH Copenhagen City Heart Study, 8577 individuals were tracked for 25 years to analyse the relationship between longevity and the type of practiced sport [6]. Taking age, gender, education, weekly physical activity, socioeconomic status, diabetes, and alcohol and tobacco consumption into account, it was found that all forms of physical activity were related to improved longevity compared to no physical activity. The greatest benefits in terms of life expectancy compared to individuals who were not physically active were observed for tennis (life expectancy greater than 9.7 years), badminton (6.2 years), football (4.7 years), cycling (3.7 years), swimming (3.4 years), jogging (3.2 years), gymnastics (3.1 years), and weightlifting (1.5 years; not statistically significant). The greatest life expectancy was related to sports involving social activities such as tennis, badminton, and soccer, which is in line with other scientific evidence showing that social isolation is a significant cause of shorter life expectancy [7].

Lipowski and Ussorowska [8] reported that men presented different motivations for physical activity than did women. For women, motives related to body figure and health were more important. The most important motives for men were physical fitness and body figure.

Kosiba et al. [9] found that as health knowledge and health education improves, pro-health

Martial arts – *plural noun* any of various systems of combat and self-defence, e.g. judo or karate, developed especially in Japan and Korea and now usually practised as a sport [82].

Combat sport – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [82].

Self-defence – *noun* fighting techniques used for defending oneself against physical attack, especially unarmed combat techniques such as those used in many of the martial arts [82].

Violence (in the praxeological sense) – physical pressure (physical force) or the application of chemical, electrical stimuli, etc., which causes the subject of action to be fling into a situation undesirable by him and becomes the object of someone's action [83].

behaviours increases, especially concerning eating habits; however, no statistically significant relationships were observed between health knowledge, health education, and physical activity among students of teaching. Researchers emphasized the association between motivation and active behaviour, health and perceived well-being in persons practicing martial arts [10]. Martial arts and combat sports – as Kalina mentioned, "every combat sport is martial arts but not vice versa" [11, p. 18] – have an educational potential, providing positive models of health behaviours [12]. When talking about martial artists, Domaneschi and Ricci [13] highlighted, right in the title of their paper: "I don't Teach Violence, I Teach Self-Control", presenting „the socio-cultural-martial context in which health behaviours are evaluated and produced".

Samoilov and Aleshicheva [14] studied the dynamics of negative states (anxiety, aggression) and hardiness in athletes during various periods of activity (between competitions, during competitions, 2-3 days after competitions). They showed that aggression, anxiety, and hardiness increased before competitions. Hardiness was directly correlated with negative emotional states. The highest levels of aggression, anxiety, and hardiness were reported during competitions. Afterwards, aggression, anxiety, and hardiness decreased, while the negative correlation between negative emotional states and hardiness became reversed. Thus, psychological tension during athletic competitions is facilitated by negative states (aggression, anger, anxiety), which the authors considered to have an active role in releasing energy reserves and mobilizing for effective activity. Researchers discuss, also, about healthy stress and unhealthy stress [15]. If the first refers to the stress that stimulates challenges and development, unhealthy stress leads to strain, hardship, and diminished well-being. In martial artists it was found that anger (aggression factor, see Buss and Perry, 1992 [16]), it was linked with a higher level of sports performance [17, 18], aspect that could not be confirmed in the case of other sports branches [19]. In the short-term, positive effect of stress during physical activity and athletic competitions was shown. However, long-term stress, especially its cumulative effects, are destructive and lower biological immunity [20], generating a poor adaptation to the environment [21]. Among martial artists from various countries, researchers underlined an increase in stress levels during the fourth wave of the COVID-19 pandemic (when compared to the first wave), which may be a consequence of prolonged negative events [22].

There are many factors maintaining appropriate physical fitness and health, including a wide variety of physiotherapeutic techniques, for example, cryotherapy, a method which employs surface stimulation using cryogenic temperatures (below −100°C) applied for short periods of time (usually between 2-5 minutes) [23]. It was developed to treat medical conditions, such as rheumatoid arthritis, multiple sclerosis [24], and started to be more and more popular among athletes. Published studies have shown the positive effects of low temperatures in athletes, whole-body cryotherapy (WBC) offering improvements in muscle soreness and subjective recovery following mechanical or metabolic overload [25, 26], when talking about a recovery from a musculoskeletal injury [27], or significant improvements in experienced pain, strength, and subjective fatigue [28]. Recent literature emphasized that future investigations regarding cryotherapy protocols for injury, recovery and rehabilitation should take into account multi-measures of performance, wellbeing, and individual response, due to the controversies regarding "the periodisation of cooling to maximise injury management or recovery" [29]. And as authors stated in 2014, "until further research (…) athletes should remain cognizant that less expensive modes of cryotherapy, such as local ice-pack application or cold-water immersion, offer comparable physiological and clinical effects to WBC." [23]. Cold baths have been proven to aid metabolic and regenerative processes in bone tissue, joint cartilage, periarticular structures, and skin. Additionally, low temperatures have anti-inflammatory and analgesic effects as well as positive effects on the treatment of diseases of the peripheral nervous system, respiratory musculature, insulin sensitivity, etc. [30, 31]. Low temperatures are also employed in treating sports injuries [32].

Winter swimming involves swimming in low-temperature water. Unlike cryotherapy, it is a cyclical behaviour, although both involve exposures to low temperature. However, cryotherapy is considered to be a less intense form of exposure. In scientific examinations of winter swimming, it is underscored that "cold water" is a relatively subjective term. Water at a temperature of below

15°C is considered to be cold. However, in winter swimming, water between 8 and 12°C is considered cold, while water below 4°C is considered to be ice-cold [33, 34]. Literature highlighted positive adaptive changes in healthy winter swimmers, and an increase in the readiness of the human body to stress factors was underlined [35]. Also, Mila-Kierzenkowska et al. [36] asserted that winter swimming combined with sauna induces adaptive response in the body, according to hormesis theory – exposure to an environmental factor (that is damaging at higher doses) leads to a beneficial effect on the organism, the cell response to stress generating adapted fitness and vitality [37].

When talking about firefighters, this category of emergency service workers is exposed to traumatizing events, the most frequently stressor being linked with „exposure to (...) major accidents or the suffering of others" [38]. When rescue was performed without the use of special protective equipment the firefighters' changes in physiological and cognitive capacity was even higher [39]. Also, almost half of the firefighters reported a poor sleep quality [40], excessive daytime sleepiness being widespread [41], while 87% of them screened positive for at least one mental health condition [42]. In Poland, it seems that 86% of the investigated firefighters experienced traumatic situations, and 78% experienced it more than once [43], while Ogińska-Bulik and Langer [44] mentioned that 18% of firefighters manifested, also, symptoms of posttraumatic stress. Relatively similar data were observed by other researchers [45], 85% of Canadian and 90% of U.S. firefighters being exposed to traumatizing events (during a year). However, the firefighters can benefit from these experiences, researchers underlining a positive correlation between stress appraisal as a challenge (while stress appraisal as a threat was negatively linked) with posttraumatic changes, expressed in posttraumatic growth [46].

The aim of the current study was knowledge about stress levels between winter swimmers and martial arts athletes (pro-health behaviours) on the one hand, firefighters and non-athletes having a sedentary behaviour (anti-health behaviours) on the other.

The following research questions were put forward:

1. Are there differences in stress levels between individuals who practice winter swimming and those who do not (martial arts athletes, firefighters, and non-athletes)?

2. Are there gender differences in stress levels between the studied samples?

The following hypotheses were put forward:

1. Stress levels will be higher in firefighters than in individuals engaging in pro-health behaviours, that is, martial arts athletes and winter swimmers.

2. The highest stress levels will be reported by individuals who do not engage in pro-health behaviours, that is, non-athletes having a sedentary behaviour.

3. Stress levels in all samples will be higher in men than in women.

MATERIAL AND METHODS

Participants and Procedure

The current study was carried out in Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia and Spain. The *sine qua non* inclusion criteria for the present research, in the case of martial artists, were: at least two years of training in a sport discipline under the supervision of a coach, and a minimum age of 18 years (the highest age was 42). In the case of major non-athletes from Poland, having a sedentary behaviour, the inclusion criterion was minimum six months without systematic physical activities. Data from the winter swimmer sample and the firefighter sample was collected between winter 2022 and early spring 2023 in the Pomeranian voivodship in Poland (Table 1)

A total of 542 participants were surveyed (online, using Google forms – Google LLC, Mountain View, CA, United States), as in previous studies [47]. Three hundred and fifty-eight participants practiced martial arts (boxing, judo, fencing, karate, kickboxing and taekwondo) for an average (in the entire sample) of 6.4 years. According to Swann et al. [48] highest standard of performance, 12.85% obtained national/international sports performances, while 87.15% registered local/regional level results. In each investigated

Table 1. Sample sizes and age.

Country	Women			Men		
	N	M_{age}	SD	N	M_{age}	SD
martial arts athletes						
Hungary	11	29.22	10.13	15	29.75	9.1
Italy	11	22.12	10.2	21	28.72	8.61
Latvia	10	24.84	7.36	20	24.66	7.18
Lithuania	32	24.88	7.71	54	24.59	5.34
Poland	19	26.47	9.03	29	25.53	8.68
Romania	30	23.01	5.39	48	22.85	6.04
Slovakia	14	24.9	6.7	21	25.58	8.45
Spain	9	31.09	10.2	14	27.6	9.11
Total	**136**			**222**		
non-athletes						
non-athletes having a sedentary behaviour	51	43.57	8.77	12	38.25	9.83
winter swimmers	51	42.18	7.21	21	41.86	8.62
firefighters	0	0	0	49	25.91	0.57
Total	**238**			**304**		

country, martial artists from both categories (according to the standard of performance) were included.

Instruments

We used the Perception of Stress Questionnaire [49]. The questionnaire was translated in Hungarian, Italian, Latvian, Lithuanian, Romanian, Slovakia, and Spanish language (from the original Polish version) with the consent and help of the author (Ryszard Makarowski). The Perception of Stress Questionnaire (in each language) was created through retroversion, being used in previous researches [50]. All authors have equally contributed to the study and questionnaire versions. The Perception of Stress Questionnaire consists of the following scales:

1. *Emotional tension*, which results from the sense of anxiety and excessive nervousness. It occurs when an individual finds it difficult to relax in various everyday situations. It is related to a lack of energy to act, the feeling of fatigue without any particular reason, as well as the tendency to resign from undertaking various tasks and fulfilling plans. High emotional tension triggers a tendency to be highly irritable in interpersonal relationships. Example items from this scale include: "I get nervous more often than I used to, and for no obvious reason," "Although I try to, I have difficulties relaxing."

2. *External stress*, which occurs when an individual is unjustly assessed by other people in various social contexts (at home, work) and when their sense of helplessness and exhaustion related to defending their point of view/position increases. External stress is experienced when an individual is used by others, becomes anxious, frustrated, or fatigued because expectations or tasks set by others exceed their own resources, skills, and coping abilities. Example items from this scale include: "I feel drained by constantly having to prove I am right," "I am criticized too frequently."

3. *Intrapsychic stress*, which is related to the inability to cope with one's own feelings and anticipations. A mental system filled with tension and conflict does not require external pressure to experience stress. This kind of stress occurs when an individual has problems with themselves and their still vivid memories from the past, creating symptoms of loneliness and anxiety. Thoughts about the future evoke anxiety, tendencies to resign, and pessimistic

assessment of oneself and the world. Example items from this scale include: "I keep being bothered by things that have happened in the past", "Thinking about my problems makes it hard for me to fall asleep."

The total stress level is the sum of emotional tension, external stress, and intrapsychic stress scores. Each scale comprises seven items. The martial artists athletes answered on a 5-point Likert-type scale, from 1 = not true, to 5 = true. The reliability of the scales in the current study was as follows: emotional tension – Cronbach's $\alpha = 0.771$; external stress – Cronbach's $\alpha = 0.746$; intrapsychic stress – Cronbach's $\alpha = 0.812$.

Additionally, data were gathered from participants through close – and open-ended questions, regarding: 1) age; 2) gender; 3) sport discipline practiced; 4) experience (in years); 5) best sports performance achieved (in the case of martial artists). Only in the case of winter swimmers, the questions examined, also, aspects such as: 1) practicing at least once a week another sport recreationally (aside from winter swimming); 2) positive changes in everyday life following the practice of winter swimming; 3) the improvement of mood on the day of winter swimming; 4) the reasons why individuals practice winter swimming. Not least, in the case of non-athletes from Poland having a sedentary behaviour, one question referred to the period (up to the time of testing) when they did not engage in systematic physical activity (minimum six months without systematic physical activities representing an inclusion criterion in the present study).

Research design

In the present cross-sectional research data from different categories were collected, without interference from the researchers. Is a quantitative study, data were gathered using the survey method, over a certain period of time.

Statistical analysis

The STATISTICA 13.0 software for statistical analysis was used, including one-factor analysis of variance (ANOVA) with Hochberg GT2 post-hoc test (for unequal sample sizes and equal variances – Levene's test $p>0.05$ [51]), and independent sample *t*-test. The normality of the distributions was verified using the Kolmogorov-Smirnov test (since $p>0.05$ the distributions are not significantly different from a normal distribution). Considering the effect size for ANOVA, *f* range intervals are: 0.10, small; 0.25, medium effect; 0.40, large [52], while for Cohen's d (effect size) the values are: 0.20, small; 0.50, medium; 0.80, large effect [53].

Ethics

The research was conducted in accordance with the Helsinki Declaration. The present study was approved by the local ethics committee of the National University of Physical Education and Sport, Bucharest, authorization number assigned is 895/SG. Written informed consent was obtained from all participants, the anonymity of the participants was ensured and data were treated confidentially.

RESULTS

Hypothesis 1 was partially confirmed. The highest levels of external stress and total stress (the sum of emotional tension, external stress, and intrapsychic stress scores) were reported by professional firefighters. This result was expected, since during their work, firefighters often face external stressors such as fire, floods, traffic accidents, mutilated bodies, death, and so forth. The highest levels of emotional tension were reported by non-athletes having a sedentary behaviour. It can be said that practicing sports regularly, whether in a sports club or recreationally, lowers emotional tension (hypothesis 2 was, also, partially confirmed).

In the case of emotional tension, the effect size index (*f*) value is 0.29, emphasizing a slightly above medium difference (overall) between the investigated groups. *f* values ranged between 0.10 (4:6) to 0.22 (4:9). When talking about external stress $f = 0.28$, indicating a medium overall effect size, with *f* ranging between 0.10 (1:7) to 0.19 (10:11). For intrapsychic stress, $f = 0.26$ (a moderate, overall, effect of the group variable on the results for intrapsychic stress being observed). *f* values ranged between 0.10 (5:7) to 0.17 (7:10). With respect to the total stress level, the *f* value is 0.28 (overall), with *f* ranging between 0.10 (4:5) to 0.18 (4:9) (Table 2).

Male martial arts athletes from Italy, Latvia, Lithuania, Poland, Romania, and Slovakia had higher stress levels than female martial arts athletes (Table 3). No statistically significant gender-related differences were observed in the

Table 2. Differences in perceived stress among professional firefighters, winter swimmers, martial arts athletes from Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia, Spain, and non-athletes.

Country		Emotional tension		External stress		Intrapsychic stress		Total stress	
	N	M	SD	M	SD	M	SD	M	SD
martial arts athletes									
Hungary (8) 1	26	18.18	6.31	15.71	4.86	15.19	4.21	49.08	14.55
Italy (1) 2	32	16.43	5.91	17.48	5.08	16.35	5.00	50.27	13.48
Latvia (3)	30	18.84	6.00	17.29	4.22	17.46	5.66	53.59	14.08
Lithuania (2) 4	86	**14.93**	4.97	15.12	4.15	14.84	5.08	**44.88**	12.55
Poland (4) 5	48	18.15	4.52	17.59	4.31	15.84	4.04	51.62	16.25
Romania (5) 6	78	17.25	7.21	16.48	5.53	16.31	5.89	50.04	16.86
Slovakia (6) 7	35	18.78	6.21	18.64	5.11	18.46	4.32	**55.88**	14.87
Spain (7) 8	23	17.52	5.54	15.39	3.78	18.13	4.28	51.04	12.19
non-athletes									
Polish non-athletes (9)	63	20.17	7.30	17.54	4.93	17.62	5.94	55.33	16.57
Polish winter swimmers (10)	72	15.81	5.80	14.85	5.06	14.26	4.77	44.92	14.04
Firefighters (11)	49	19.92	6.37	18.92	5.62	17.08	5.64	55.92	15.90
F		7.172		7.078		5.854		7.179	
p		***		***		***		***	
Differences		2:9***; 4:3***; 4:6****; 4:9***; 4:11***; 9:10**; 10:11*		1:7*; 1:11*; 3:4**; 3:10**; 4:5**; 4:7***; 4:11***; 7:8*; 7:10***; 10:11***		1:7*; 3:10*; 3:4***; 4:7*; 5:7*; 7:10***; 9:10*; 10:11*		3:4***; 3:10*; 4:5*; 4:7***; 4:9***; 4:11**; 9:10**; 10:11*	
f		0.29		0.28		0.26		0.28	

Note. *p≤0.05, **p≤0.01, ***p≤0.001; *f* = 0.25 indicates a medium overall effect size.

Table 3. Gender differences in stress levels: winter swimmers, martial artists from Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia, Spain, and persons not engaging in pro-health behaviours.

Country	Variables	Women		Men		t	p	Cohen's d
		M	SD	M	SD			
Hungary	Emotional tension	17.86	6.98	18.56	5.38	−0.430	0.669	0.11
	External stress	15.78	4.89	15.37	4.90	0.327	0.745	0.08
	Intrapsychic stress	15.25	5.30	15.11	5.19	0.104	0.918	0.03
	Total stress	48.89	15.19	49.04	13.94	−0.040	0.968	0.01
Italy	Emotional tension	15.71	5.45	19.33	6.97	−1.946	0.057	0.58
	External stress	16.69	4.76	20.67	5.28	−2.534	0.014	0.79
	Intrapsychic stress	15.92	4.75	18.08	5.81	−1.351	0.182	0.41
	Total stress	48.31	11.80	58.08	17.21	−2.329	0.023	0.66

Country	Variables	Women		Men		t	p	Cohen's d
		M	SD	M	SD			
Latvia	Emotional tension	17.79	5.45	20.20	6.41	−2.834	0.005	0.40
	External stress	16.80	4.05	17.84	4.39	−1.722	0.087	0.25
	Intrapsychic stress	16.39	5.07	18.75	6.10	−2.949	0.004	0.42
	Total stress	50.97	12.51	56.78	15.29	−2.919	0.004	0.42
Lithuania	Emotional tension	14.34	4.51	16.25	5.68	−2.418	0.017	0.37
	External stress	14.66	3.85	16.13	4.62	−2.215	0.028	0.35
	Intrapsychic stress	13.65	4.31	17.52	5.62	−5.039	0.000	0.77
	Total stress	42.64	10.96	49.89	14.36	−3.707	0.000	0.57
Poland	Emotional tension	17.23	5.99	19.04	7.09	−1.556	0.122	0.28
	External stress	16.41	5.04	18.67	5.82	−2.339	0.021	0.42
	Intrapsychic stress	14.74	5.02	16.85	6.04	−2.141	0.034	0.38
	Total stress	48.38	14.34	54.57	17.39	−2.185	0.031	0.39
Romania	Emotional tension	15.82	6.41	19.13	7.94	−3.033	0.003	0.46
	External stress	15.71	5.15	17.65	5.89	−2.300	0.023	0.35
	Intrapsychic stress	15.05	5.40	18.08	6.15	−3.444	0.001	0.52
	Total stress	46.57	15.10	54.86	18.13	−3.275	0.001	0.50
Slovakia	Emotional tension	17.79	6.35	20.26	5.74	−1.970	0.052	0.41
	External stress	18.15	5.09	19.54	5.09	−1.339	0.184	0.27
	Intrapsychic stress	17.48	5.06	20.08	4.89	−2.540	0.013	0.52
	Total stress	53.42	14.94	59.87	14.06	−2.161	0.033	0.44
Spain	Emotional tension	17.80	5.67	17.00	5.51	0.379	0.707	0.14
	External stress	15.45	3.82	15.27	3.90	0.123	0.903	0.05
	Intrapsychic stress	18.45	4.76	17.55	6.31	0.451	0.656	0.16
	Total stress	51.70	12.20	49.82	12.66	0.406	0.688	0.15

Table 4. Gender differences in stress levels: winter swimmers and persons not engaging in pro-health behaviours.

Country	Variables	Women		Men		t	p	Cohen's d
		M	SD	M	SD			
Polish winter swimmers	Emotional tension	15.43	5.85	15.96	5.83	-0.352	0.726	0.09
	External stress	13.71	4.51	15.31	5.24	-1.224	0.225	0.33
	Intrapsychic stress	13.24	5.24	14.69	4.55	-1.174	0.244	0.30
	Total stress	42.38	14.55	45.96	13.83	-0.983	0.329	0.25
Polish non-athletes having a sedentary behaviour	Emotional tension	20.42	7.23	20.12	7.38	0.127	0.900	0.04
	External stress	20.00	4.59	16.96	4.87	1.966	0.054	0.64
	Intrapsychic stress	17.08	6.04	17.75	5.98	-0.344	0.732	0.11
	Total stress	57.50	16.03	54.82	16.81	0.500	0.619	0.16

Hungarian and Spanish athlete samples, as well in the Polish winter swimmers and Polish non-athletes having a sedentary behaviour.

In the current research only male firefighters were examined, therefore, gender-related differences in terms of stress levels could not be verified (Table 4). On a side note, as Sinden et al. [54] argued "female firefighters represent a minority group in this male dominated occupation".

DISCUSSION

Why do winter swimming and physical exercise during sports improve the organism's immune system? Already in the 16th century, the Swiss physician Paracelsus stated that it is the dose (and not the substance) which makes the poison (*Dosis facit venenum*). This phenomenon is called hormesis and it means that a substance which is harmful in larger doses has a beneficial effect on the organism when used in smaller ones. Winter swimming can be considered a factor which activates thermoregulatory processes increasing the organism's tolerance for stressors [55, 56].

It may be assumed that regularly training in martial arts would make this sample report the lowest stress levels rather than the winter swimmers. Martial arts are related to aggression, which, in turn, increases stress. However, results are mixed on this point. Vertonghen and Theebom [57] carried out a meta-analysis on martial arts and aggressive behaviors showing that longer training is related to lower aggression levels. Pacesova and Putala [58] examined aggression levels among swimmers, extreme sports athletes, and non-athlete adolescents. The highest levels of overall aggression and verbal aggression were reported by the non-athletes. Also, regularly practicing sports lowers children's aggression and increases their self-control and discipline [59-61].

Bjorkqvist & Varhama [62] reported that men training in karate had a more positive attitude towards resolving conflicts than did wrestlers and boxers. Moreover, they found that women training in karate engaged in brutal conflict-solving more frequently than did women from the control group. The authors suggested that women may associate karate with the right to physical self-defence against assault, while men may associate it with non-violent defence.

The current study showed that winter swimming is related to lower stress levels, which means that winter swimmers possess higher psychological and physiological resources. Researchers emphasized that winter swimmers (after four months) felt themselves to be more active, brisk and energetic than the controls and, also, swimmers who suffered from asthma, rheumatism, or fibromyalgia, declared that winter swimming had relieved pains [63]. Moreover, Lindeman et al. [64] reported that the winter swimming improved positive mood and had relieved physical symptoms.

A contrary result was observed in the professional firefighter sample. It could be assumed that their high external stress levels are determined situationally, by frequent contact with external stressors. This sample also reported high emotional tension levels, and, generally, higher scores (with respect to perceived stress) than martial arts athletes or winter swimmers. Researchers asserted the need to use "a symptom measure consistent with the full DSM-IV criteria to more fully assess firefighters' responses of fear, helplessness, and horror" [65]. It is known that personal resources determine coping with stress, and the levels of perceived stress. Studying firefighters, it was found that stress appraisal as a challenge determines positive posttraumatic changes [46]. However, because firefighters (during their careers) are experiencing potentially traumatic events, emotion regulation, mood and relationship satisfaction could be affected [66]. Therefore, interventions for individual firefighters to improve health (at physical, psychological and cardiovascular level) are recommended [67].

With respect to winter swimmers, Chęcińska-Maciejewska et al. [33] found that almost half of the women (40.09%) and over half of the men (57.38%) engaged in physical activity a few times per week. Almost half of these individuals (45.69%) declared that they never catch colds. This study leads to the conclusion that most winter swimmers maintain their physical fitness through regular and varied physical activity. In the current study, the winter swimmers most frequently indicated their experience as between three and five seasons. Aside from winter swimming, every person practiced some sport recreationally at least once per week.

Additional self-report data on winter swimmers collected as part of the current study pointed

to positive changes in everyday life in 91% of the sample, while 86% of the sample reported a noticeable improvement to mood on the day of winter swimming. Why do individuals practice winter swimming? For some, it is a lifestyle, while for others, it is mere showmanship. However, the majority of winter swimmers claim that it brings them peace, calmness, happiness, and cleansing. It is a way for them to improve control over their bodies and minds. Moreover, winter swimming causes endorphin secretion [68]. The dominant age group (53%) in the winter swimmer sample (in the current research) consisted of people between 40 and 49 years old. The next 21% of the sample was comprised of people aged between 30 and 39 years, while only 14 people aged between 50 and 80 years (the mean age of the entire sample was 42 years – Table 1). On the other hand, the mean age of the martial arts athlete sample was 26 years. Age may only partially explain the lower stress levels in the winter swimmer sample.

Physical health has gained particular attention in recent years. COVID-19, the Russo-Ukrainian war, and civilizational changes have led to reduced physical activity, which translates into greater vulnerability to illnesses [69]. However, physical activity is one of the factors contributing to a healthy lifestyle and a strong immune system. To rate the dynamics of experienced stress and the coping strategies used during the subsequent waves of the COVID-19 pandemic, a longitudinal study using the Perception of Stress Questionnaire and the COPE questionnaire was carried out in 2020 on a sample of professional athletes in Poland, Romania, and Slovakia [70]. The results showed that the highest levels of intrapsychic stress in all countries were reported during the fourth wave of the pandemic. Moreover, the highest emotional tension levels were reported by the Polish and Slovak athletes during the fourth wave. The coping strategies used by the athletes during the fourth wave were more dysfunctional than those used during the first wave.

Investigating gender-related differences in stress levels, researchers underlined that female gender is linked with higher stress level [71] (general population was investigated). Studies suggested, also, that women have a stronger inborn and developed (humoral and cellular) immune response to viral infections, women and men reacting differently with stress, both biologically and psychologically [72]. For example, compared to men, women are infected with COVID-19 half as frequently, and with less severity and mortality [73, 74]. In sports, it seems that women athletes (compared with men athletes), "are at greater risk of a range of psychological stressors that contribute to health concerns and mental health disorders" [75]. However, as Asztalos et al. [77] mentioned, very little difference in emotional-distress and perceived-stress "existed in women and men who participated in different sport-types" [76]. Considering martial artists (elite taekwondo fighters), the difference between women and men in the levels of anxiety was statistically non-significant – anxiety and stress influence each other, when a person is more anxious he/she becomes more stressed, and vice versa. Our study showed that in martial arts, male athletes from Italy, Latvia, Lithuania, Poland, Romania, and Slovakia reported higher stress levels than female martial arts athletes. Hypothesis 3 was confirmed partially. Statistically significant results were not observed in the sample of Hungarian and Spanish athletes, in winter swimmers and non-athletes.

Physical conditioning may be one element contributing to physical and mental health. It can be stimulated by low temperatures. Cold, as well as winter swimming, are considered a type of stressor. Thermal stimuli, in this case, the cold, are perceived by the brain and cognitively appraised as a potential threat. The physical pain caused by the cold additionally exacerbates this perception of threat. Thus, taking control over the cold is key during winter swimming. This transforms the psychological processes underway in this situation into adaptive ones, impacting emotions and personality. Not everyone can become a winter swimmer, for example, due to health issues or place of residence. Nevertheless, given appropriate conditions, winter swimming together with training in sports may lower emotional tension, external stress, and internal stress.

The present study has some limitations. The findings may be different if martial artists from a single sport discipline would be examined, or if grouped in striking (kickboxing, boxing, fencing, taekwondo, karate), grappling (judo), respectively striking and grappling combat sports. Also, the results could be different if athletes from other continents (not only from Europe) would be investigated, or taking into account the sports

performances achieved (only martial artists having international performances, national or only local/regional sports results). Future research should focus, for example, only on men or women winter swimmers (of different ages). Female professional firefighters should also be investigated, even if they represent a hard-to-reach population. Finally, the explicit measures (self-report scales) could be considered as a limitation, athletes being able to provide possible desirable answers [78] (self-report scales can be susceptible to biases). Researchers proposed a questionnaire-based implicit association test (qIAT) to evaluate different psychological constructs (see, for example [79, 80]). However, the questionnaires (self-report measures) are critical tools in research worldwide [81], and the relatively large number of participants in the present study representing a strength of the work.

CONCLUSIONS

In summary, we underline that the highest levels of external stress and total stress were reported by professional firefighters. This sample, also, reported high emotional tension levels, and, generally, higher scores (with respect to perceived stress) than martial arts athletes or winter swimmers. Winter swimming is related to lower stress levels, which means that winter swimmers possess higher psychological and physiological resources. Winter swimming together with training in sports may lower emotional tension, external stress, and internal stress. The results emphasized, also, that male martial arts athletes from Italy, Latvia, Lithuania, Poland, Romania and Slovakia had higher stress levels than female martial arts athletes. No significant gender-related differences were observed in the sample of Spanish and Hungarian athletes, in winter swimmers and non-athletes having a sedentary behaviour.

The current study can be of interest for martial artists, winter swimmers, sports psychologists, coaches, specialists working with firefighters, being aware that physical fitness alone, possessed by professional firefighters, is an insufficient buffer against stress, in contrast to winter swimmers.

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