

# Business Intelligence Application for Analyses of Stress Potential Zones in the Population Doing Sports

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**Abstract.** The article presents the results of the research focused on stress factors followed in two groups – top-level athletes and recreational sportsmen. With regard to the methods used in the research the answers obtained in subjective questioning were statistically processed and then the respondents were classified into the zones of stress potential. In the field of frustration tolerance half of the top-level sportsmen group have low to average value of stress factors. The situation is similar in the recreational sportsmen group where 50 % of them also show low to average value of stress factors. As far as coping with stress is concerned it has been revealed that about two thirds of the surveyed top-level athletes and three quarters of the recreational sportsmen group are included into the optimal stress zone. The electronic online application which enabled subjective questioning and classification into stress factors was set up and placed on the web.

**Keywords:** Frustration tolerance · Handling stress · Psychosomatic symptoms · Web application · Database

## 1 Introduction

An important element in reducing stress factors is physical fitness. People who regularly do *aerobic exercises*, that is any kind of endurance activity which increases heart rate and oxygen consumption – e.g. running, swimming, cycling or cross-country skiing – have significantly lower heart rate and blood pressure in a stress situation than other untrained people.

Physically fit individuals tend to fall ill as a result of stress events less often than people who are not in a good condition. In relation to these facts the programmes for coping with increased stress load are currently focused on *physical fitness*. The study on patients suffering from chronic chest pain has revealed that the combination of stress management techniques and regular exercise resulted in less frequent occurrence of angina pectoris than the actual stress management training [1].

## 2 Theoretical Basis

### 2.1 Mental and Physical Health

The belief of connection between physical exercise and mental health is known from the history of ancient times. It is reflected in the message *mens sana in corpore sano* – *there is a healthy mind in a healthy body*. The science started to be interested in this relation much later and it has not brought a closer understanding of the relation between physical exercise and mental health until the recent years [2, 3]. In 2004 the representative of the British Ministry of Health came up with the thought that *it is necessary to think about physical activities not only with respect to their therapeutic effect on mental illnesses but also due to their impact on mental health*. (Ministry of Health, DH, 2004: 58–59).

With the growth of intensity of physical activity the positive mood decreases and the negative mood increases even though the reaction to the load is not the same with all people. After finishing exercise the *back-reflection effect* occurs during which the mood improves. Although further research needs to be conducted, it is possible to say that people doing regular exercises are less likely to be depressed. Moreover, exercises are recommended as a suitable therapy of mild to medium depression, in combination with other interventions (pharmacotherapy or psychotherapy) and under the control of a qualified mental health specialist. Research confirms the British Ministry of Health statement that active people have fewer symptoms of anxiety than inactive people. After all, physical activity significantly affects people with bad physical condition and high level of anxiety. It turned out that exercise is a feasible intervention for cancer patients, even those who are undergoing chemotherapy and suffering from an acute stage of the disease – here a number of benefits were recorded, such as the quality of life improvement and a depression decline [4].

### 2.2 Frustration Tolerance

Frustration is defined as a state threatening the integrity of organism when a person must engage all abilities to protect himself/herself. The effort based on the natural necessity of satisfying a person's needs is blocked. In a narrower sense, frustration is the result of dissatisfying biologically primary, instinctive claims or the failure in achieving a goal, which is accompanied by feelings of destruction. As one of the determinants of human behaviour frustration is sometimes incorrectly mistaken for deprivation or the phenomenon of unfinished activity, which has similar symptoms as frustration.

Manifestations of frustration fall into the area of perception and behaviour disorders and often acquire the character of neurovegetative or psychosomatic symptoms. They depend not only on the intensity and length of duration of frustration but also on *a person's resistance to frustration – so called frustration tolerance*.

The ability of frustration tolerance is connected with inborn properties of an individual (temperament, emotional stability versus instability) and further with influences of social environment (family influence and acquired experience) [5].

Although frustration can cause aggression, anxiety as well as neurovegetative disorders [6], it is an inseparable part of human life. Gradual and bearable frustration loading of organism even leads to increased psycho-physiological resistance of an individual.

### 2.3 Dealing with Stress

Stress is generally understood as exertion, load, as an adaptation stimulus, as a demanding situation that must be managed by an athlete – physical load (training) and mental load (competition). The following degrees of load can be distinguished: extreme, excess, boundary, increased, adequate, optimal, negligible. In fact, load is any energetic demand on the organism. Reference [7] There is a known concept of organism as a balanced system (homeostasis) which is deflected by a load and tends to regain the balance again. According to the adaptation theory [8] every other analogous load causes a smaller deflection, the organism gradually adapts to loads. The essence of training programmes for athletes is based on this fact.

In the 20th century the *theory of stress* brought a new approach to the issue of load. Its author is Hans Selye [9] who found out through experiments that all loading stimuli (stressors) from a certain intensity lead to triggering a nonspecific reaction in the organism (i.e. always the same regardless of the initiator of stress), called general adaptation syndrome (GAS). It progresses in three phases: 1st – alarm (alarm reaction), typical for mobilization, inefficiency, 2nd – resistance, defence by drawing from energy storage, 3rd – exhaustion, spreading the reaction onto the whole organism, collapse. The criterion of GAS progress is production of hormones preparing the organism for physical exertion.

In fact stress is intensive emotion with all the activating consequences. The asthenic emotion is called distress, the sthenic emotion is eustress. Depending on the place affected by a stressor we speak about physical stress when it affects periphery (most often pain), and mental stress which is cerebral, brain, mental. For example, the ankle distortion means the physical stress for an athlete and the disqualification from the race is the mental stress. The response of the organism to both stress types is the same, unspecific, global. It differs only in intensity. The main criterion is the amount and kind of hormones identifiable in blood, saliva etc. (corticoids, adrenalin, noradrenalin, cortisol, hydrocortisol) [10].

The most frequent stressors in sport are expectation based tension (see pre-start condition, fear when taking a risk), demands of the programme, defeat, injury, loss of physical condition or disqualification.

Intensive and long-term distresses mean quality of life worsening and they can have an unpleasant impact on health – today this issue is dealt with by a modern field of *psychosomatic medicine*.

### 2.4 Psychosomatic Symptoms

Psychosomatic symptoms in a stress situation during sport activities can be classified into three groups:

*Organic* – palpitation (the heart beat is too strong, fast and irregular in relation to the current exertion), losing breath and sweating without an exertion cause, chest pain, cramps and pain in the bottom part of stomach, metabolic disorders – loss of appetite, enormous muscle tension, especially in the area of cervical and lumbar spine, migraines that spread from the neck to the top of the head and forehead.

*Emotional* – sharp mood fluctuation, hypochondria, dreaming, autistic thinking, lack of concentration, neurotic symptoms, inadequate tiredness, fear from social contact, loss of empathy, impulsiveness.

*Behavioural* – decline in performance, loss of physical condition, worsened quality of training preparation, taking anaesthetics, disorders of life rhythm (insufficient sleep, chronic tiredness), excesses in behaviour, tendency towards isolation [11].

As it can be concluded from the previous enumeration, the difficulty in diagnostics results from variety and also contradiction of symptoms which are sovereignly individual. Unlike a physical illness, which manifests itself e.g. by a fever, the situation in psychosomatic symptoms is unclear and the affected person often refuses to admit the seriousness of his/her condition. A frequent danger in sport is overtraining, which has stress effects. Psychological dangerousness lays in the fact that it is the result of good intentions, increased motivation and big effort to assert oneself. The cause are big training dozes and underestimating the regeneration of performance disposition. A lot of coaches of top-level athletes still see regeneration as a luxury. It results in protracted stress conditions. Therefore it is absolutely essential not to underestimate psychosomatic symptoms in a stress situation, regard them as a warning signal and adopt routine measures to eliminate them.

### 3 Methodology

#### 3.1 Method of Research and a Group of Respondents

The method of a questionnaire survey was used in the research on the basis of subjective evaluation according to the questionnaire by Micková [12, 13].

The research was focused on finding out stress factors in three sectors:

1. frustration tolerance – the form of YES/NO questions was used here
2. handling stress, i.e. behaviour in a stress situation – the form of questioning by means of assessing scale was used and two aspects of the research were followed here – the amount of emotional reaction to stress and the amount of using mal-coping (harming) strategies
3. psychosomatic symptoms - the form of questioning by means of assessing scale was used here

#### 3.2 Group of Respondents

50 athletes in total were included in the research set. Most of the athletes were secondary school or university students.

*Top-level athletes – cross-country skiers, 25 men; age 19–25 (Ø 21) years.* The athletes were selected into this set according to the criterion of sport performance efficiency. At the time of the survey they belonged to the 1st class of performance efficiency and they regularly took part in the races of Czech Cup or a higher category (at least 5 races). At the same time 15 athletes from this set were or still are the members of the representation team. However this was not the condition for inclusion into the research. For none of the athletes sport was the source of livelihood. With regard to various training methods it can be assumed that at the time of racing period, during which the research was carried out, the average weekly sport activity occupied between 10 and 15 h. It should be noted that the athletes of this group belonged mostly to the Czech performance top level.

*Common population doing sport as a leisure activity, 25 men; age 21–25 (Ø 22.5).* The athletes selected into this set do a sport regularly in various sport activities, maximum of 8 h a week (the average of a weekly sport activity was 5 h in this set), at the same time they were not included in any representation team and currently did not have their performance efficiency certified in any sport. On the basis of the collected data it can be said that this group represents common population doing sport as a leisure activity which mostly does not interfere with the life of the athletes.

### 3.3 Procedure of Conducting the Research

Modern technologies were used for doing the research. It was carried out with the help of the company Google Inc., thanks to which the questionnaire was converted into electronic form and the company Facebook Inc. enabled direct communication with the respondents – each of them was approached individually on the basis of pre-prepared list of names. Thus obtaining proper answers only from the selected people was guaranteed. The research was conducted and gradually statistically processed in the years 2013–2014. 88 questionnaires in total were sent off, out of these 64 (73 %) completed questionnaires were used.

*Set 1 – Top-level athletes – cross-country skiers:* Sent off 40 questionnaires, returned completed 30 (75 %).

*Set 2 – Common population doing sport as a leisure activity:* Sent off 48 questionnaires, returned completed 34 (71 %).

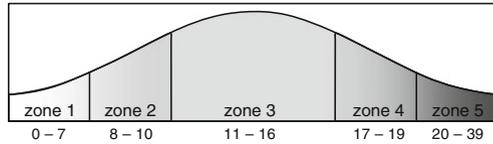
Consequently the number of respondents was reduced to 50 (25 in each of the two sets) due to meeting assigned criteria. Individual components of the questionnaire were evaluated in points. The statistical significance of differences was owing to a small number of subsets ( $n = 25$ ) calculated by means of Mann-Whitney U-test. For statistical processing a complement for Excel, trial version of the program SigmaXL was used.

### 3.4 Characteristics of Stress Potential Zones

**Zone 1:** The stress level is *very low*. The personality needs to be encouraged and motivated in his/her life so that they could use their abilities better. Here it is necessary

to realize the existence of so called positive stress – eustress which enables to manage the demands of modern life, strengthens and develops a human personality (Fig. 1).

**Zone 2:** The stress level is *low*. It can be connected with introvert orientation of the personality and a stabilized way of life progressing without changes and excitement. The personality is in a rather balanced life situation and does not have to be afraid of stress-related diseases.



**Fig. 1.** Zones of stress potential

However he/she does not use all their abilities. It is necessary to place bigger demands on themselves, set more ambitious goals and overcome passivity.

**Zone 3:** The stress level is *average*. It is an optimal zone of stress potential. Most of the population find themselves in this zone. In the personality's life the periods of increased load alternate with the periods of peace and relaxation. For achieving goals the certain stress level is necessary but it must not be permanent and long-term. Increased load-peaceful condition rhythm enables a person to live a balanced and satisfying life.

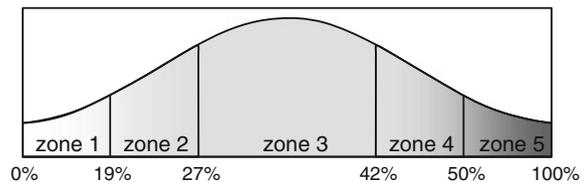
**Zone 4:** The stress level is *high* and it means a warning signal. The personality should explore individual areas of his/her life and consequently decide which problems need a quick solution. This way mental problems as well as threatening physical problems can be turned away. It is time to change the lifestyle and prevent complications. It is necessary to seek advice from close friends and relatives or ask for a professional help. It is also advisable to get to know strategies of coping with excessive stress.

**Zone 5:** The stress level is *dangerously high*. The personality is currently experiencing abnormally high stress. He/she has serious problems requiring an urgent solution. The personality is no longer capable of helping himself/herself a so it is necessary to seek professional help of a psychologist or a psychiatrist.

## 4 Results

### 4.1 Zones of Stress Potential

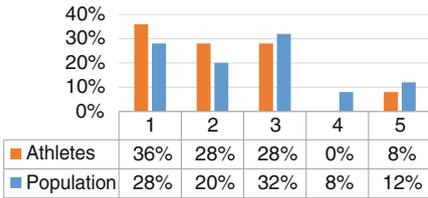
The limit values of individual stress potential zones were converted into their percentage in the scale 0 (0 %) up to 39 (100 %; see Fig. 2). Also the point results of each respondent from individual questionnaires were converted into percentage.



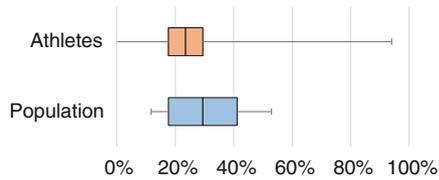
**Fig. 2.** Zones of stress potential converted into percentage

### 4.2 Frustration Tolerance

First of all numbers of inclusion in stress potential zones were compared for frustration tolerance of the group of top-level athletes – cross-country skiers and of common population sportsmen (see Fig. 3).



**Fig. 3.** Comparison of numbers of inclusion in zones for frustration tolerance of groups of athletes and common population sportsmen



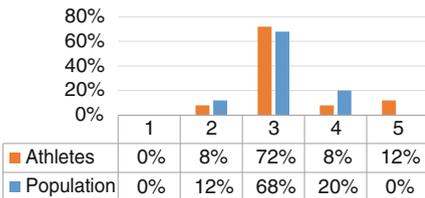
**Fig. 4.** Boxplot representation of amount of frustration tolerance in top-level athletes and common population sportsmen

Half of the group of **athletes** (approx. 12 people) range on the border of zones 2 and 3 (18–29 %). Other members (other approx. 12 people) diverge from the average of the group by their inclusion in zones – they are more divergent.

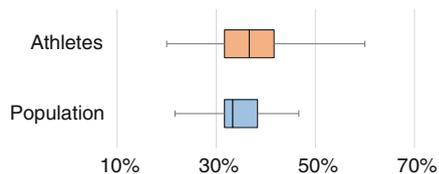
Half of the **population** group (approx. 12 people) is included in zones 2 and 3 (18–41 %). The group does not contain too different/divergent individuals. Other members (approx. Other 12 people) do not diverge from the group average by their inclusion in zones as in the athletes group. Further a boxplot representation of the amount of frustration tolerance in athletes and population groups was created for a more detailed comparison (Fig. 4).

### 4.3 Handling Stress

First of all we compared numbers of inclusions in zones for optimal handling stress of the top-level athletes group and the group of common population sportsmen (Fig. 5) a then for a more detailed comparison a boxplot representation of the amount of stress handling by top-level athletes and common population sportsmen was created (Fig. 6).

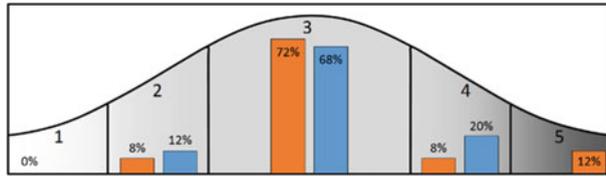


**Fig. 5.** Comparison of numbers of zone inclusions for optimal handling stress by groups of athletes and common population sportsmen



**Fig. 6.** Boxplot representation of amount of stress handling by top-level athletes and common population sportsmen

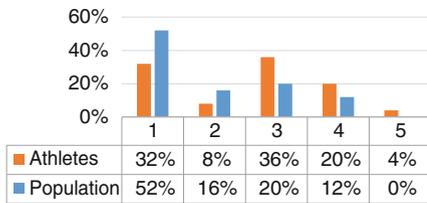
68 % of group members of **athletes** fall into stress zone 3 which is the healthiest one with respect to handling stress. 72 % of group members of **population** again fall into stress zone 3 which is the healthiest one with respect to handling stress (Fig. 7).



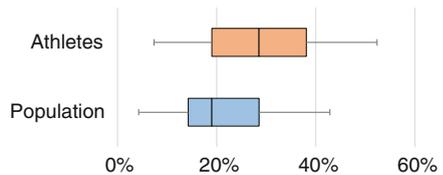
**Fig. 7.** Number of psychosomatic symptoms in groups of top-level athletes and common population sportsmen

### 4.4 Psychosomatic Symptoms

Further the research focused on the comparison of the numbers of inclusions in stress potential zones for psychosomatic symptoms in the groups of top-level athletes – cross-country skiers and common population sportsmen (Fig. 8).



**Fig. 8.** Comparison of numbers of inclusions in zones for psychosomatic symptoms in groups of top-level athletes and common population sportsmen



**Fig. 9.** Boxplot representation of amount of psychosomatic symptoms occurrence in top-level athletes and common population sportsmen

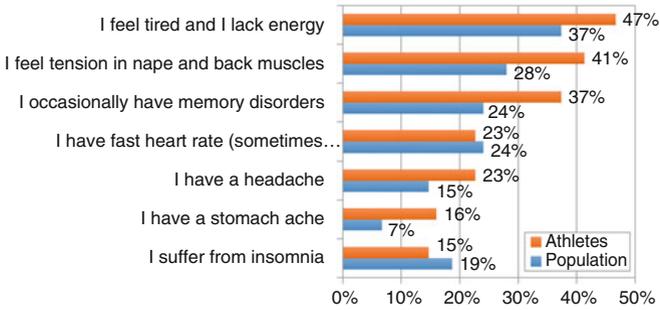
Approximately the same number – one third – of group members of **athletes** occur both in stress zone 1 and zone 3. More than a half of group members of **population** are from the point of view of psychosomatic symptoms included in stress zone 1.

Consequently, for a more detailed comparison a boxplot representation of amount of psychosomatic symptoms occurrence in top-level athletes and common population sportsmen was created (Fig. 9).

Further we focused on the comparison of amount of individual psychosomatic symptoms in the groups of top-level athletes and common population sportsmen (Fig. 10).

Consequently, the number of psychosomatic symptoms was found out in the groups of top-level athletes and common population sportsmen (Table 1).

From the above mentioned symptoms the group of top-level athletes show feelings of tiredness and lack of energy most often (47 %). In the group of common population



**Fig. 10.** Comparison of amount of individual psychosomatic symptoms in groups of top-level athletes and common population sportsmen

**Table 1.** Number of psychosomatic symptoms in groups of top-level athletes and common population sportsmen

	Population	Athletes
1	I feel tired and I lack energy 37%	I feel tired and I lack energy 47%
2	I feel tension in nape and back muscles 28%	I feel tension in nape and back muscles 41%
3	I have fast heart rate 24%	I occasionally have memory disorders 37%
4	I occasionally have memory disorders 24%	I have a headache 23%
5	I suffer from insomnia 19%	I have fast heart rate 23%
6	I have a headache 15%	I have a stomach ache 16%
7	I have a stomach ache 7%	I suffer from insomnia 15%

sportsmen the situation is similar, the feelings of tiredness and lack of energy are shown also in the highest rate (37 %).

The second position in the table is held by feelings of tension in nape and back muscles in the group of athletes (41 %) and also in the group of common population sportsmen (28 %).

In the third place top-level athletes show memory disorders (37 %) and common population sportsmen fast heart rate sometimes connected with excessive heart beat (24 %).

### 5 Application for Independent Testing

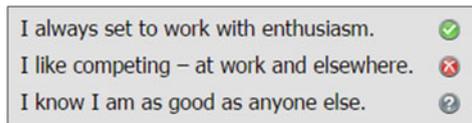
The data for this research was obtained by individual respondents filling in printed paper questionnaires. That brought a few difficulties such as the distribution of questionnaires, time and space limitation for filling them in, insufficient anonymity, collection of completed questionnaires, conversion of data into a digital form and its statistical processing.

In order to eliminate these problems in future or at least reduce them considerably, an on-line business intelligence application was created which facilitates the whole process significantly. Users then do not fill the data in the paper forms but on-line in web forms,

which is more preferred [14]. Thanks to that it is also possible to reach far larger sample of respondents because apart from those directly involved in the project other “anonymous” volunteers can participate in the research. All the recorded data is available immediately after it is entered and thus it can be automatically continuously evaluated.

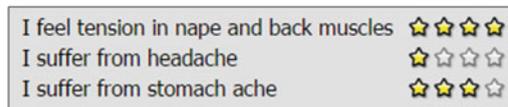
This application is freely available on the address <http://qol.alltest.eu/stress>. Here we can find a signpost to all three questionnaires relating to stress: Frustration tolerance, handling stress and Symptoms of stress. The first one includes yes/no question type and for better user comfort the answer is selected only by clicking (with a mouse or a finger on the touch device) on the icon which gradually switches over from the original state of a question mark  (answer not selected) to the option yes  (for the approval of a statement on a given line) and consequently no  (for the disapproval of the appropriate statement; see Fig. 11).

In other two forms answers are given on a scale 0–3, which was simplified here by the selection of number of stars. It expresses a degree of agreement with a given item (1 star – total disagreement, 4 stars – total agreement; see Fig. 12).



**Fig. 11.** Illustration of filling answers in Frustration tolerance questionnaire

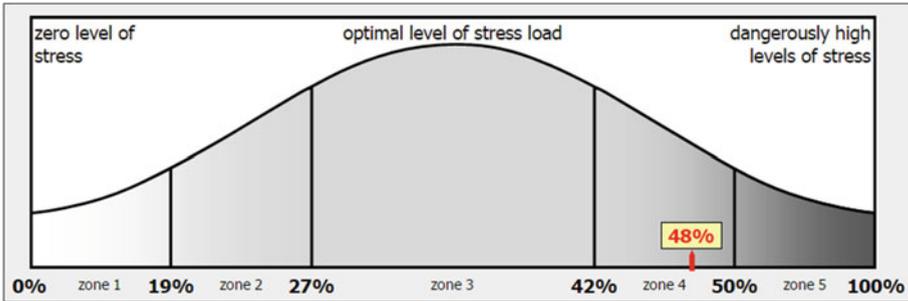
After filling in all the items in the questionnaire the user clicks on the push button *Evaluate* and immediately a graphic evaluation is displayed and in percentage put in the appropriate stress zone (see Fig. 13).



**Fig. 12.** Illustration of filling answers in questionnaire Symptoms of stress

A constituent part of the questionnaire is also the data for categorization of respondents (see Fig. 14): year of birth (for putting in the age group), sex, occupation (student of secondary school, university student, worker, senior) and determination of intensity of doing sport activities (regularly, sometimes, never). Name and e-mail are optional but in case of filling them in they can serve for the evaluation of the development of individual stress level in time.

The complete data of the questionnaire is during the evaluation simultaneously saved in a database on the server for later anonymous, collective, statistical processing. This gives us a possibility to continue in the research all the time with the growing sample of respondents and thus with more relevant results.



**Fig. 13.** Illustration of questionnaire evaluation – putting user in stress zone

Birth year	1980	Sex	Male
Profession	working	Movement	any sport ever
Name		E-mail	

**Fig. 14.** Illustration of filling in categorization data about user

For the future we also plan to extend the evaluation of each questionnaire by the comparison of individual figures with average results of the other respondents. This way users will also get information on what their figures are in relation to the whole population, the same age group, the same sex etc.

## 6 Conclusion

Physical activities can represent an effective prevention of the development of both physical and mental illnesses.

Our research was comparing two groups, the group of top-level athletes and the group of common population doing sport on a recreational basis. In the area of *frustration tolerance* it has been found out that a half of the top-level athletes group (approx. 12 people) ranges on the border of the second and third zone of stress potential (18–29 %), where the third zone is understood as an optimal zone, the healthiest one. The other members (the other 12 people) diverge more from the average of the group as far as the inclusion in the zones is concerned. They are more divergent. A half of the common population group (approx. 12 people) is included in the second and third zone (18–41 %). The individuals in this group are not as different as in other group. The other members (the other 12 people) do not diverge from the group average as much as top-level athletes do when the inclusion in the zones is concerned.

In the area of *handling stress* it was revealed that 68 % of members of the top-level athletes group fall into the 3rd stress zone, which is the healthiest one concerning handling stress. In the population group 72 % of its members fall again into the healthiest third stress zone.

In the area of *psychosomatic symptoms* the group of top-level athletes show in the first place feelings of tiredness and energy shortage (47 %). The similar situation is in the group of common population doing sport for pleasure where the feelings of tiredness and energy shortage are also shown in the highest rate (37 %). The second position in the table is held by the feelings of tension in nape and back muscles in the athletes group (41 %) and also in the common population group (28 %). In the third place the top-level athletes show memory disorders (37 %) and the common population sportsmen state fast heart rate sometimes connected with excessive heart beat (24 %).

On the address <http://qol.alltest.eu/stress> the original electronic application was created in the Czech and English version thanks to which it is possible to reach much larger sample of respondents because apart from those directly involved in the project other “anonymous” volunteers can participate in the research. All the recorded data is available immediately after it is entered and thus it can be automatically continuously evaluated.

Physical activities, exercise and sport can thus represent an effective *prevention* of physical and mental illness development. However the fear of self-presentation may be one of the factors which prevent people from doing exercises and thus make them deprived of these preventive effects. When introducing exercise interventions specialists must take into consideration *individual routine of exercise* in order to ensure the possibility of achieving optimal benefits for a particular individual.

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