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SHORT TERM EFFECTS OF SIMULATION TRAINING ON STRESS, ANXIETY AND BURNOUT IN CRITICAL CARE HEALTH PROFESSIONALS / A BEFORE AND AFTER STUDY

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Declaration of competing interest

All authors declare they have no conflict of interest to disclose.

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1 **Short term effects of simulation training on stress, anxiety and burnout in**
2 **critical care health professionals: a before and after study**

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Abstract

Introduction

Anesthesia and critical care professionals have been shown to be particularly affected by the problems of stress, anxiety and burnout. Simulation training could be a sustainable solution to help healthcare workers to deal with this situation. There is however poor scientific evidence on the short-term effect of simulation training on stress, anxiety and burnout in anesthesia and critical care workers.

Material and methods

This prospective observational study was conducted over one year. All anesthesia and critical care professionals participating in simulation training for critical situations were considered for inclusion. Perceived Stress Score (PSS), State Trait Anxiety Inventory (STAI) and Maslach Burnout Inventory (MBI) were collected before and 1 week after the training.

Results

Ninety-three participants fully completed the before and after study. PSS levels were significantly lower after the simulation sessions ($p = 0.008$), as were STAI levels (anxiety state ($p < 0.001$) and anxious personality trait ($p = 0.002$)). The severity of burnout levels also decreased after simulation training ($p < 0.001$).

Conclusion

Simulation training based on critical situations exposure seems to have positive and rapid effects on stress, anxiety and burnout in anesthesia and critical care staff.

Keywords: simulation – stress – burnout – anxiety – prevention

35 **1. Introduction**

36 Anesthesia and Critical Care Medicine professionals are exposed to stressful situations with
37 important personal and/or professional consequences. [1–5] They have been shown to be
38 particularly affected by the problems of stress, anxiety and burnout, especially during the
39 COVID-19 pandemic. [6,7] There is a need to act and find sustainable solutions to help
40 healthcare workers to deal with this situation.

41 Training using simulation could be a relevant solution by allowing progressive learning with
42 different levels of complexity, exposure to different clinical situations, improving learner’s
43 confidence. Simulation can be used as a curricular tool for learners throughout their training.
44 Procedural simulation allows the development of technical skills reproducing care acts. It
45 constitutes a basic foundation for the training of health professionals. These technical gestures
46 are carried out with patients as in the simulated participant or hydride simulation modality.
47 Finally, this user care is performed within the framework of interprofessional clinical activity
48 with different healthcare actors, such as during a full-scale interprofessional simulation
49 session. In this curricular vision of simulation, each modality is used in order to gradually
50 increase the complexity of the cases by adapting to the level of the learners. Training for
51 exposure to stress can improve clinical performance. [8] Simulation training seems to
52 influence work-related stress and turnover of nurses. [9] During the debriefing phase, the
53 creation of a motivating learning experience appears to be essential to improve the learner’s
54 confidence at work. [10] The immersion during simulation is able to reproduce emotions
55 close to those observed in the clinical practice. [11] However, psychological safety can be
56 guaranteed during simulation training by making it clear during the pre-briefing that
57 participants can leave the session if they feel the need to. Simulation seems to be successful in
58 desensitizing healthcare workers to stress facing critical clinical situations. [12]

59 The effect of simulation training on stress could be rapid. There is however poor scientific
60 evidence on the short-term effect of simulation training on stress, anxiety and burnout in
61 anesthesia and critical care workers. The main objective of this study was to evaluate the
62 short-term impact (1 week) of simulation training on commonly perceived stress, anxiety and
63 burnout in this population. We hypothesized that simulation training could rapidly improve
64 the stress of healthcare workers.

65

66

67 **2. Material and methods**

68

69 **2.1 Design of the study**

70 We conducted a prospective single-center observational before/after study on stress of
71 healthcare workers around a simulation-based training intervention from January to December
72 2019 (**Figure 1**). This study was approved by the Ethics Committee of the University of
73 Toulouse Jean Jaures (CERNI-Université Fédérale de Toulouse - number 2016-009, approval
74 without specific comments). The study design was pre and post intervention comparison. The
75 pre-evaluation was done the day before the simulation session. The post assessment was done
76 one week after the training session to comply with the recommendations of the scales used.
77 All participants were contacted one week after their training. We did a follow-up in the
78 following week.

79

80 **2.2 Simulation training**

81 The study site was the Toulouse Institute for Simulation Training in healthcare. This
82 simulation center receives more than 6000 participants each year. The themes of the sessions
83 were defined around critical situations, as malignant hyperthermia, massive hemorrhage in the
84 operating room, respiratory distress in the recovery room, initial management of severe
85 multiple traumas in the intensive care unit. The critical situation simulation sessions included
86 4 scenarios during the training day. The simulation modality was full scale, i.e. the
87 participants were immersed in an identically reproduced work environment (operating room,
88 trauma room, recovery room, etc.). During the training day, the participants alternated
89 between 3 positions: actors, rescue actors and observers. Actors were the participants who
90 started the simulation session. Rescue actors were participants who could be called upon by
91 the actors to assist in the management in the same way that healthcare professionals can call
92 for help in clinical practice. Finally, observers were participants who were not actors in the
93 session but who observed the session without any part in the management and who
94 participated in the debriefing. Thus, participants were involved in 2 simulations and observed
95 2 simulations. The simulation sessions lasted 15 to 20 minutes and the debriefings lasted 45 to
96 60 minutes. Regardless of their posture, all participants were present during the debriefing of
97 the session. In order to standardize the debriefings and avoid differences between sessions, all

98 debriefings were conducted according to the PEARLS model. [13] The debriefing team was
99 systematically composed of a physician and a nurse specialized in critical care or anesthesia.

100

101 **2.3 Participants**

102 All participants in 31 sessions were offered inclusion in the study. They expressed their
103 written informed consent to participate in the study. Each training day consisted of 8–10
104 people working in critical care (anesthesiologist and critical care physicians or residents,
105 nurse anesthetists, ICU nurses, student nurses' anesthetists and nursing assistants).
106 Participants were asked to maintain their professional posture during the training.

107

108 **2.3.1 Inclusion criteria**

109 The main inclusion criterion was to be a participant in a full-scale critical situation simulation
110 session. It was compulsory to work in an anesthesia-intensive care unit (operating room,
111 intensive care unit, trauma room, etc.). Each participant had to have given written informed
112 consent.

113

114 **2.3.2 Exclusion criteria**

115 Participants whose personal or professional experience could be affected by a major personal
116 or professional event that would alter the scales were not considered for inclusion. For
117 example, if the participants had a death in the family or a separation or had experienced a
118 difficult conflict or layoff, etc. This personal assessment was left to the discretion of the
119 participants and was present on the written consent. In addition, the consent form listed a
120 number of resources (internal and external psychologists, occupational medicine, quality of
121 life at work advisors, etc.) to be contacted if necessary. Thus, a potential resource was made
122 available to the participants if they felt the need and desire to do so. A second exclusion
123 criteria was no response to the assessment before or after the training session.

124

125 **2.4 Data**

126 Three validated scales were used for the assessment of stress, anxiety and burnout. Depending
127 on the recommendations of each scale, they were re-informed between 1 and 4 weeks after the
128 exposure.

129

130 **2.4.1 Perceived Stress Score**

131 The Perceived Stress Score (PSS) was created in order to measure the stressful nature of
132 situations. [14] It was translated and validated in French. [15] The PSS 10 is able to measure
133 perceived stress both in terms of its psychometric qualities and its application. [15,16] The
134 PSS 10 consists of ten items that participants are asked to quantify in terms of frequency of
135 occurrence using a five-point Likert scale ranging from never (1) to often (5). Questions 4, 5,
136 7 and 8 are reversed, with scores ranging from 5 for never to 1 for often. This scale is part of a
137 transactional approach to stress. The PSS takes into account an individual's perception of the
138 demands of a situation as well as the resources and abilities they feel they have to control the
139 situation.

140 The PSS 10 scores were classified into three categories:

- 141 - 21 or less: person managing stress
- 142 - 22 to 26: person generally manage stress but some situations remain complex
- 143 - 27 and above: person does not manage stressful situations and feels under constant
144 threat of perpetual threat

145

146 2.4.2 State Trait Anxiety Inventory

147 The State Trait Anxiety Inventory (STAI) was created by Spielberger, Gorsuch and Lushene.
148 [17] It was translated and validated in French. [18] This questionnaire includes 20 questions
149 for the state of anxiety and 20 for the anxious personality traits. Indeed, as we wanted to use
150 scales based on transactional stress and thus a self-assessment of individuals regarding their
151 ability to act in situations, we found it relevant to add a scale taking into account the
152 personality of individuals.

153 The forty questions are to be assessed using four-point Likert scales. Some of the questions
154 are reversed, 10 for the anxiety state and 9 for the anxiety personality trait. Each item is
155 scored from 1 to 4, with 1 being the lowest and 4 the highest degree of anxiety. The summed
156 score ranges from 20 to 80.

157 The STAI scores were classified into the following categories

- 158 - 35 or less: very low
- 159 - 36 to 45: low
- 160 - 46 to 55: medium
- 161 - 56 to 65: high
- 162 - 66 or more: very high

163

164 2.4.3 Maslach Burnout Inventory

165 The Maslach Burnout Inventory (MBI) was used for the specific level of burnout of
166 healthcare workers. [19] It was translated and validated in French. [20]

167 This inventory includes three dimensions:

168 —Depersonalization

169 —Emotional exhaustion

170 —Personal accomplishment at work

171 The first two dimensions are elements in favor of burnout, whereas personal accomplishment
172 at work is a protective element. The MBI consists of 22 questions to be assessed on a Likert
173 scale of intensity and/or frequency. When interpreting, each item is scored from 0 to 6 and the
174 dimensions can be scored as low, moderate or high.

175 For depersonalization and emotional exhaustion, high levels indicate serious impairment; for
176 personal fulfillment, low levels indicate weakness. It is sufficient for one of the three
177 dimensions to be affected to speak of burnout. Depending on the number of dimensions
178 affected, it is possible to distinguish three stages of severity:

179 — Low: one dimension affected

180 —Moderate: two of the three dimensions are affected

181 —Severe: all three dimensions are affected

182

183 **2.5 Data collection tools**

184 We created a computerized questionnaire including the 3 selected scales. The computerized
185 questionnaire was hosted in compliance with French law and the National Commission for
186 Information Technology and Civil Liberties. We added socio-demographic questions to
187 characterize the cohort. Participants in the simulation sessions had to fill in the questionnaire
188 before their training. In accordance with the recommendations of the three scales in a before-
189 and-after study, individuals were contacted one week after their participation in a simulation
190 session. Indeed, after one week, it is not possible to say whether the potential changes in
191 scores are due to the intervention or to other factors.

192

193 **2.6 Statistical analysis**

194 Data were expressed in number and percentage for categorical variables and mean \pm standard
195 deviation (SD) for quantitative variables. A paired t-test was performed to compare scale
196 levels before and after the intervention. The value of $p \leq 0.05$ was used as the threshold of
197 significance. Qualitative data was expressed as a percentage and materialized in histograms
198 compiled as a percentage for easy visualization. Regression's analysis was performed to

199 evaluate the risk factors of stress, anxiety and burnout. A Pearson test was performed between
200 the different scales to assess their correlation with each other. Statistics were computed using
201 Stata software (v16, StataCorp, College station, USA).

202

203 **2 Results**

204

205 **3.1 Socio-demographic data**

206 Of the 258 people participating in the simulation sessions, 209 agreed to participate in the
207 study, with 93 responses after the simulation sessions. The socio-demographic data of the
208 cohort are shown in **Table 1**.

209

210 **3.2 Perceived stress before/after**

211 The raw data results of the PSS are presented in **Table 2**. PSS was significantly lower after
212 simulation-based training ($p = 0.008$). After training, individuals were more likely to handle
213 stressful situations ($p = 0.017$). (**Figure 2**).

214

215 **3.3 Anxiety and anxious personality trait before/after**

216 The raw data results of the STAI state and trait are presented in **Table 2**. Anxiety state ($p <$
217 0.001) and anxious personality trait ($p = 0.002$) decreased after the training. The share of
218 healthcare professionals with a low or very low anxiety state or personality trait increases by
219 10% (**Figure 3**). Both pre- and post-session levels of anxiety states were consistently and
220 significantly lower than individuals' personality traits ($p < 0.05$).

221

222 **3.4 Burnout before/after**

223 The severity of burnout levels was significantly ($p < 0.001$) lower after training (**Figure 4**).
224 The results of the three dimensions of MBI are presented in **figure 5**. Emotional exhaustion (p
225 $= 0.522$) and depersonalization ($p = 0.889$) were similar before and after the training these
226 dimensions of burnout did not change significantly. In contrast, professional accomplishment
227 increased significantly after the training ($p < 0.001$) (**Figure 6**).

228

229 **3 Discussion**

230 The primary purpose of this study was to examine the short-term effect of simulation-based
231 training on three scales commonly used to measure perceived stress, anxiety and burnout. A

232 positive effect of training based on full-scale simulation of critical situations has been
233 observed as perceived stress was reduced with participants feeling to better handle stressful
234 situations after the training, anxious personality trait of individuals significantly improved,
235 and the severity of burnout were lower after the session.

236 Simulation seems to be able to improve the perception of stress. Simulation based-training
237 increases participants' positive stress coping abilities. [21] Stress training is relevant because
238 it improves actual performance in a critical clinical situation. [22] The military, for example,
239 is experimenting with personnel optimization techniques, including methods related to stress
240 management. These techniques improve the physiological effects of stress and perceived
241 stress. [23] In the transactional model of stress developed by Lazarus and Folkman, the notion
242 of resources to cope with stressful situations is important. [24] Thus, training to acquire or
243 develop skills can improve the coping strategies of individuals. It is all the more relevant to
244 look at stress as high levels of stress are linked to a decrease in the quality of care. [25–27]

245 We were able to demonstrate a decrease in STAI levels after a simulation training session.
246 However, when the simulation is used as a means of assessment, STAI levels increase. [28]
247 When simulation is used as a learning method, STAI levels decrease after training. [29] This
248 effect of decreasing STAI is effective in simulation-based training for anesthesia and
249 intensive care residents. [30] Simulation is stressful and anxiety-provoking, however, levels
250 of anxiety states were consistently lower than individuals' personality traits. This means that
251 the health professionals were comfortable with their usual state.

252 The ultimate manifestation of stress is burnout when a worker has been consumed by stress.
253 The choice of the MBI for the study as a burnout scale can be debated but we obtained levels
254 comparable to the literature, for people practicing in anesthesia before the training. The
255 improvement obtained is in line with the results obtained by El Khamali *et al.* through
256 simulation sessions. [9] The development of the MBI's dimension of professional
257 accomplishment has led to an improvement in burnout levels. The change in these two
258 indicators suggests a real and profound impact of simulation-based training among healthcare
259 professionals. During simulation-based training, health professionals create social links
260 between peers. This social support is a factor in improving burnout. [31] Training to develop
261 coping strategies improves the well-being of residents. [32] This is likely to prevent burnout.
262 Simulation of critical situations to develop personal and interpersonal resources can be a
263 means of preventing or improving the level of burnout among health professionals.

264
265

266 **Limitations**

267 This study has some limitations.

268 The pre-post method we used can be discussed. The guidelines of the National Institutes of
269 Health (NIH) quality assessment tool for before after (Pre-Post) study without a control group
270 were followed. Only validated scales were used, with a relatively short delay between their
271 collection. The post-session data were collected one week after the training in order to remain
272 consistent with the scales used. It would be interesting to make longer-term measurements
273 and to measure the persistence of the effect of the simulation.

274 Secondly, the current study was conducted in a single center and one specialty. It would be
275 interesting to carry out the same study but in a multi-centre approach and with other
276 specialties that experience critical situations, such as emergency medicine, to confirm these
277 results. In addition, it would be interesting to evaluate the maintenance of the gain on the
278 scales in the longer term. This would require further study to determine.

279 Finally, the use of a qualitative method such as an interview could have provided information
280 on the characteristics of stress, the sources or factors of anxiety and ill-being at work.

281

282 **4 Conclusion**

283 Simulation training based on critical situations exposure seems to have positive and rapid
284 effects on stress, anxiety and burnout in anesthesia staff. Simulation, beyond being a learning
285 device, seems to have positive effects on psychological parameters. This offers interesting
286 perspective as the use of simulation training as a prevention tool in healthcare population
287 exposed to stress, anxiety and burnout.

288

289

290

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293 and the professionals who agreed to participate in our study.

294

295

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396 **Table 1. Description of the cohort - socio-demographic data**
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Description of the cohort

		n = 93	%
Gender			
	Female	71	76
	Male	22	24
Age			
Junior:		38	41
	< 30 years	38	41
Senior:		55	59
	30 to 39 years	39	42
	40 to 49 years	13	14
	50 to 60 years	3	3
Profession			
Paramedical staff:		76	82
	Care assistant	20	21.5
	Nurse	42	45
	Nurse anesthetist	8	9
	Student nurse anesthetist	6	6.5
Medical profession:		17	18
	Resident in anesthesia and critical care	17	18
Status:			
	Professional	70	75
	Student	23	25
Place of practice			
	Operating room	28	30
	Recovery room	13	14
	Care service	3	3
	Specialized critical care	12	13
	Intensive care unit	33	35.5
	Other	4	4.5

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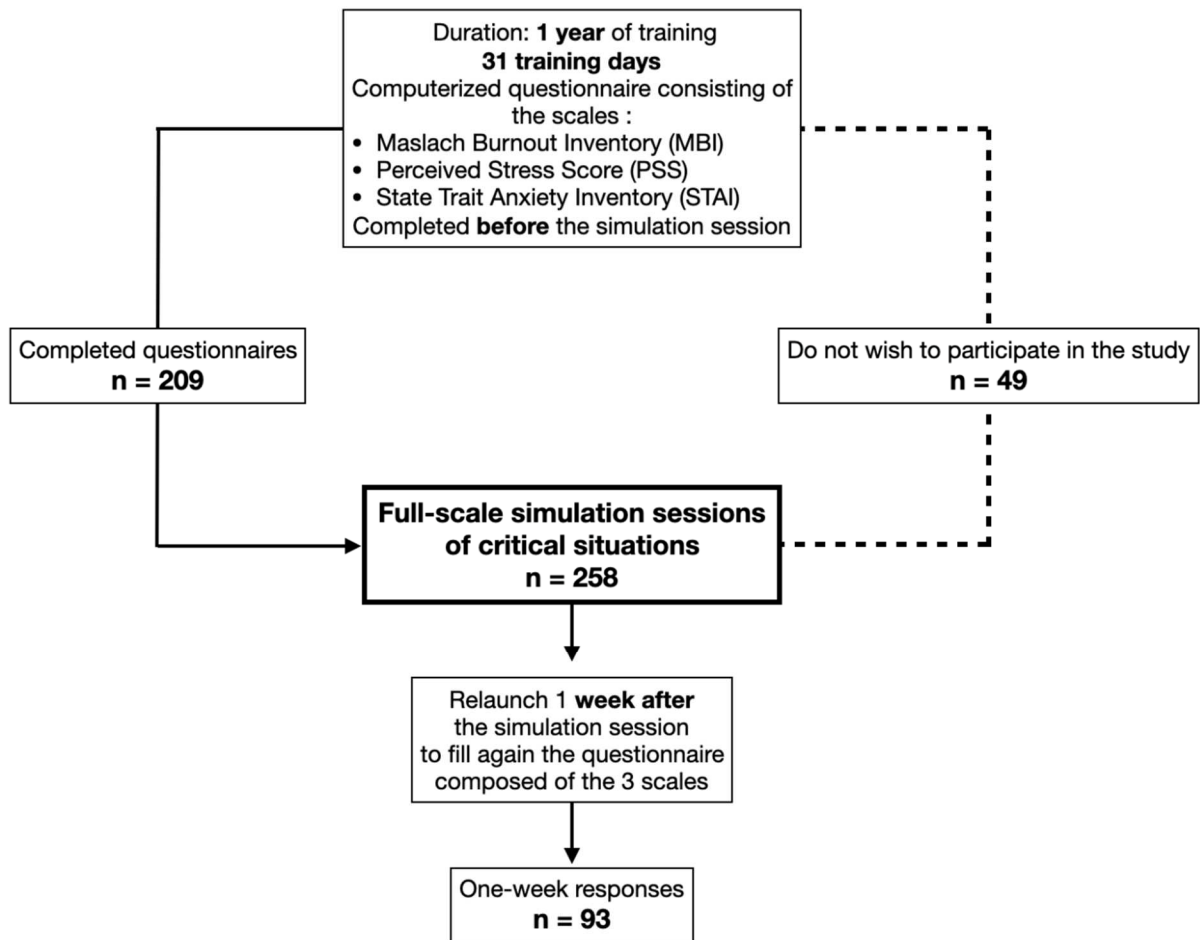
406 **Table 2. Scales results in numerical values: Perceived Stress Score (PSS), State Trait**
 407 **Anxiety Inventory (STAI) – Difference of the t-test**
 408

n = 93		Before	After	p value*
PSS	Mean	25.7	24.6	p = 0.008
	SD	4.52	5.01	
	SEA	0.47	0.52	
STAI Trait	Mean	39.1	37	p = 0.002
	SD	7.58	8.58	
	SEA	0.79	0.89	
STAI State	Mean	39.1	34.9	p < 0.001
	SD	8.82	8.25	
	SEA	0.91	0.86	

409 **t* test, hypothesis: Before > After
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423 **Figure 1. Flow chart of the study**

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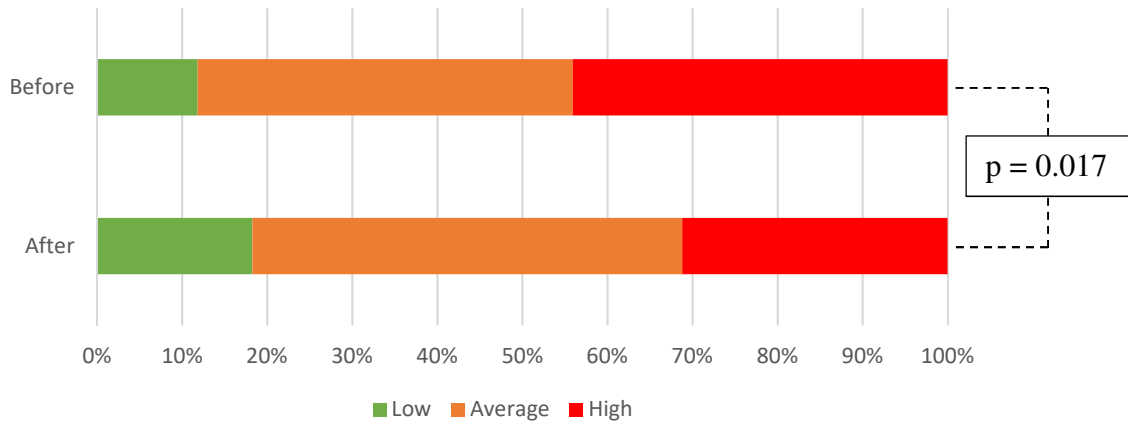


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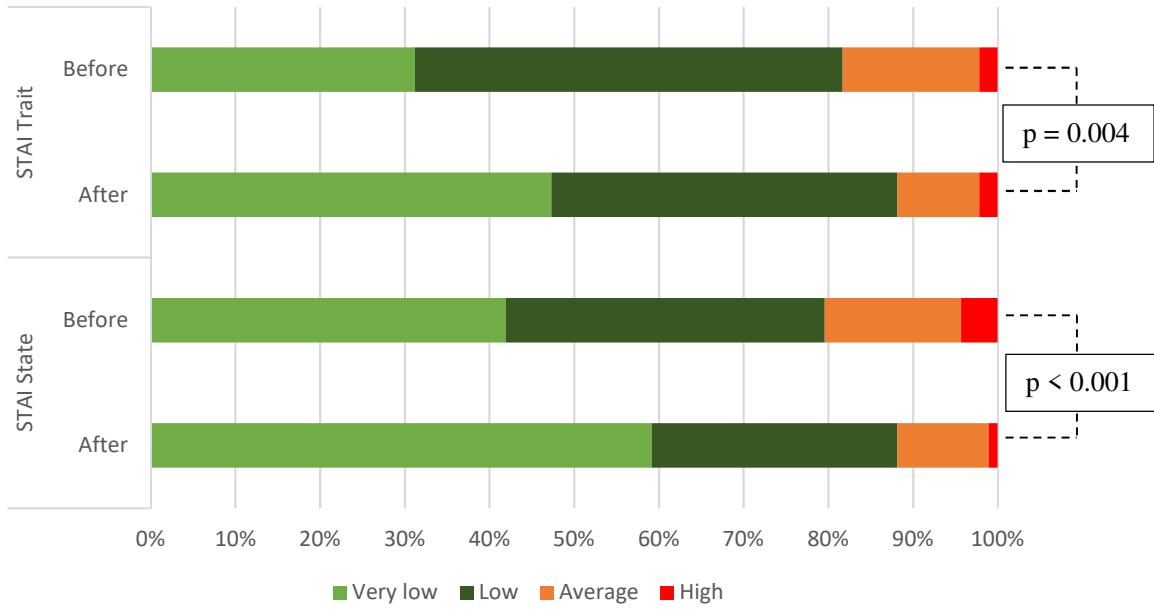
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428 **Figure 2. Perceived Stress Score (PSS) results according to score levels - (histogram**
429 **compiled in percent)**



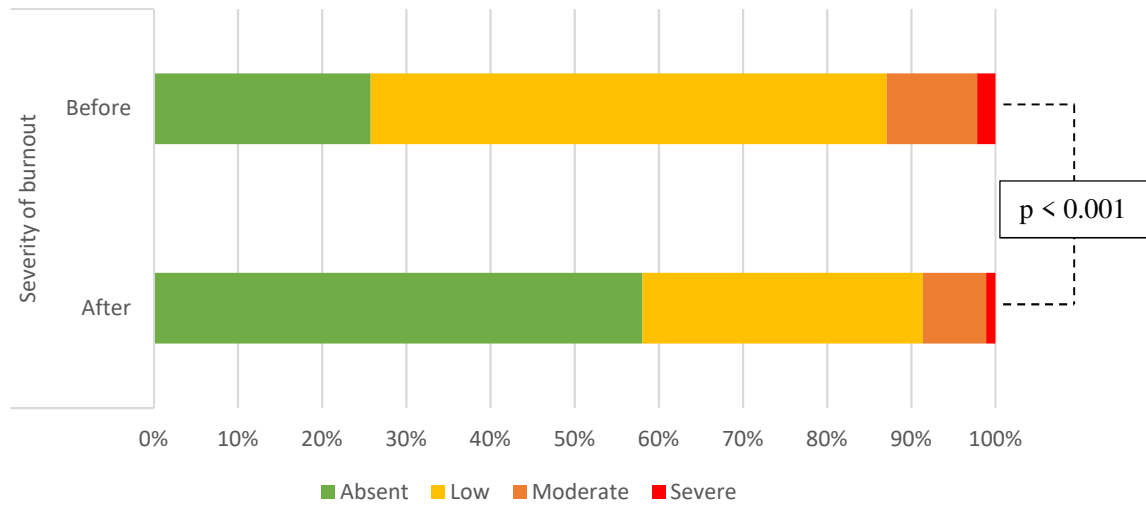
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433 **Figure 3. State Trait Anxiety Inventory (STAI) results according to scale levels –**
 434 (histogram compiled in percent)
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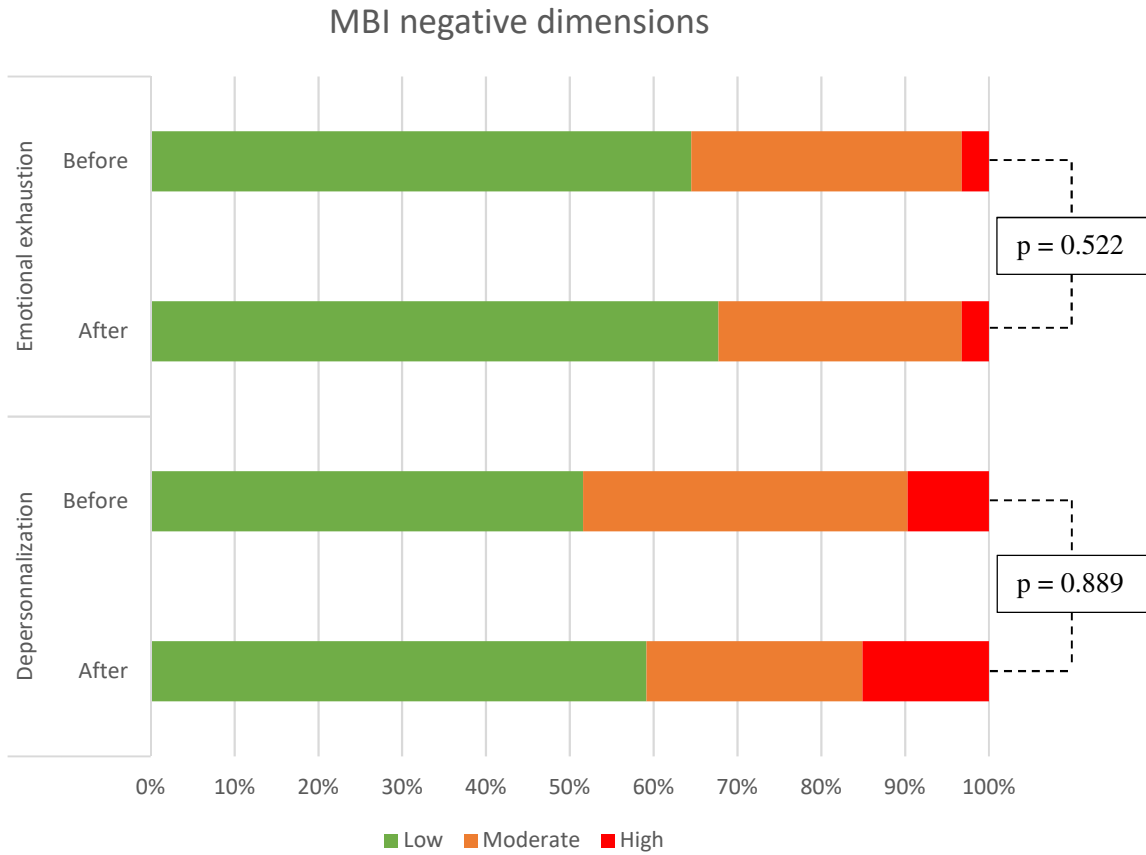
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438 **Figure 4. Severity of burnout level before and after simulation-based training –**
439 **(histogram compiled in percent)**
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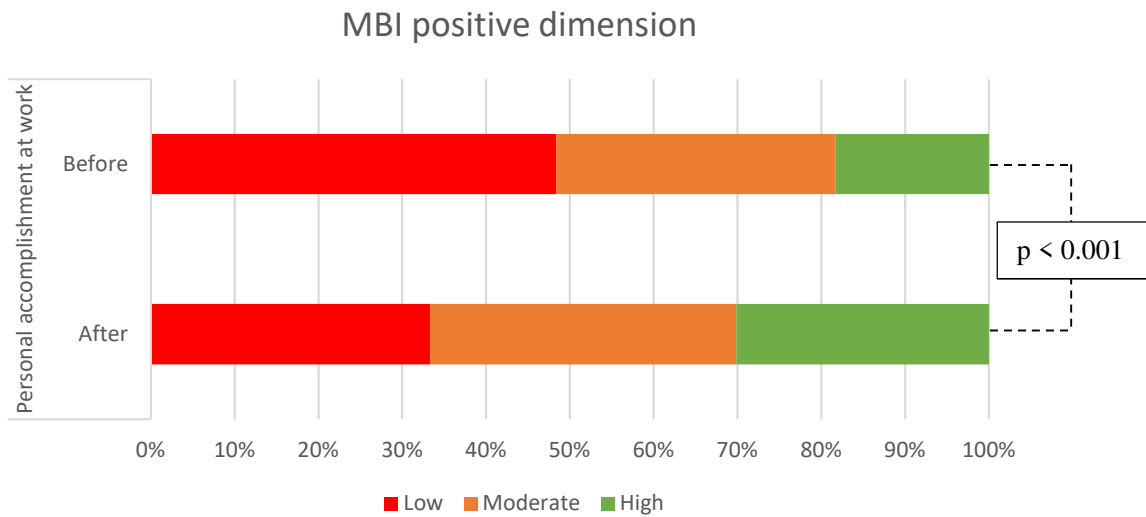


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473 **Figure 5. Maslach Burnout Inventory (MBI) results according to scale levels and**
 474 **dimensions – negative or positive dimensions**
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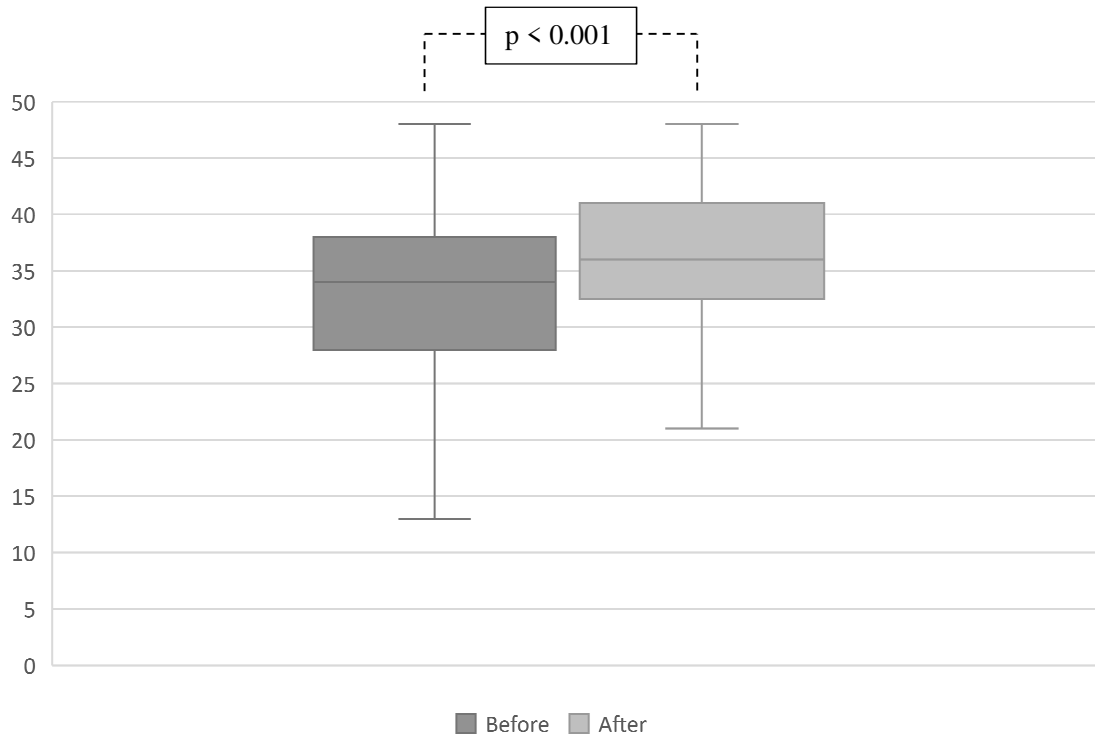
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Figure 6 - Difference in the level of personal accomplishment at work before and after training



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