Clinical Trial

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The alteration of stress-related physiological parameters after probiotics administration in oral surgeons with different degrees of surgical experience

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Abstract

Purpose. Stress is a multifactorial and complex pathway, gaining growing attention from the healthcare community. Surgeons are subjected to higher levels of stress, due to surgical procedures that are demanding and repetitive; unfortunately, high-stress levels may also cause side-effects, as surgical mistakes. This study aimed to evaluate the efficacy of specific probiotics strains formula on stress levels in oral and maxillofacial surgeons, to improve their quality of life.

Methods. We have investigated the hormonal (salivary Cortisol; sC), immune (salivary Immunoglobulin A; sIgA) and cardiovascular (Heart rate, HR, and systolic blood pressure, SBP) responses induced by stress conditions in 40 oral surgeons, randomly selected and allocated, according to their experience level, in three categories: senior, expert, and junior.

Results. The results described how the number of heartbeats/minute and SBP are slightly raised in all surgeons at different timepoints. Such data allow us to assess that work-related stress can induce an increase in cardiovascular parameters, even if they are not significantly modified by the use of probiotics. On the other hand, our data indicate that 10 weeks of probiotic integration may induce the improvement of other stress-related physiological parameters in oral surgeons with different degrees of surgical experience, such as the salivary cortisol levels, even under stress conditions. Moreover, in the test group (probiotics administration), the immunoglobulin levels were higher than the control (placebo administration) group: this happens as a consequence of the regular use of probiotics, which may induce an increased number of IgA producing cells.

Conclusions. our data indicated that 10 weeks of probiotics-enriched diet modify some stress-related physiological parameters in oral surgeons with different degrees of surgical experience, but it does not impact on the overall cardiovascular risk. ***Clin Ter 2020; 171 (3):e197-208. doi: 10.7417/CT.2020.2214***

Key words: *Probiotics, Human health, Dietary supplementation, oral surgeons*

Introduction

Nowadays, the concept of stress is multifactorial and complex to understand correctly. The most reliable categories of stressors could be listed as follows: physical (systemic or reactive) and psychological (emotional or processing) (1,2). The health professionals are subjected to higher levels of occupational-stress than average workers (3). It is easy to understand that surgical procedures are physically demanding and that high levels of stress may be normal during surgical performances; unfortunately, high-stress levels may also cause surgical mistakes that can compromise patients' safety (4-8). General dental professionals and in particular oral and maxillofacial surgeons (4,5), are exposed to psychological and physiological stress outcomes such as depression and mental disorders, secondary hypertension and cardiovascular diseases, impairment of immune system, obesity, metabolic disorders, and oxidative stress, and higher risk of developing neurodegenerative diseases such as Alzheimer's disease (1-3,10).

The mechanisms of action by which prebiotics might confer health benefits have been tested via in vitro and animal models and include defense against pathogens, immune modulation, increased mineral absorption, improved bowel function, metabolic effects and effects on satiety (11-15).

The aim of this study was to evaluate the efficacy of specific probiotics strains on stress-related health parameters in oral and maxillofacial surgeons.

Materials and methods

This study is a clinical trial carried out on volunteers. It was conducted in collaboration with the Elbasan University (School of Technical Medical Sciences, "A. Xhuvani"), Albania, and the University of Bari Aldo Moro as a ran-

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domized, double-blinded placebo-controlled study. The Institutional Ethics Committee of the Faculty of Technical Medical Sciences of Elbasan "ALEKSANDËR XHUVANI" has approved the application to conduct the clinical trial in the Faculty. Title of the Protocol: Probiotics efficacy and safety in humans. Protocol Identification: INTL_ALITCOOP/Probiotics/INRES2019_w/a/c.

The study was carried out according to the Helsinki declaration and informed written consent was obtained from all the subjects.

Study Design

A computer-generated double randomization sequence was carried out by an investigator who was not directly involved in the treatment and the assessment of the subjects (13).

Surgeons were randomly selected and randomized into one of two groups, according to their experience level, in three categories: senior, with more than 10 years of experience; expert, between 5 and 10 years of experience; junior, with less than 5 years of experience. Was also classified the type of surgical procedures in three categories according to the increasing of technical difficulty: easy (e.g. simple extraction surgery); intermediate (e.g. routine implantology); complex, which includes procedures of objective difficulty (e.g. sinus surgery and multiple implants insertion), and procedures of subjective difficulty (e.g. oral cysts removal or apicectomy) (3).

Clinical Outcomes

In this study were analyzed the hormonal (salivary Cortisol; sC), immune (salivary Immunoglobulin A; sIgA) and cardiovascular (Heart rate, HR, and systolic blood pressure, SBP) responses induced by stress conditions in 40 oral surgeons (all males), randomly recruited according to their expertise level from baseline to 10 Weeks. Saliva has been collected using a Salivette® (Sarsted) swab which allows collecting 1 mL of saliva.

The participants were asked not to alter their routine habits during the study and randomly allocated to receive either a placebo (tablets looking similar but without probiotics) or tablets containing a specific targeted synbiotic (*Hyperbiotics PRO-15 ADVANCED STRENGHT*), containing 15 different probiotics patented stains (*Lactobacillus plantarum*, *Lactobacillus acidophilus*, *Bifidobacterium infantis*, *Lactobacillus fermentum*, *Lactobacillus reuteri, Lactobacillus casei, Bifidobacterium Longum, Lactobacillus rhamnosus, BifidobacteriumLactis, Lactobacillus salivarius, Lactobacillus paracasei, Bifidobacteriumbificum, Lactobacillus gasseari, Bifidobacterium Breve and Streptococcus thermophilus*), patented for LiveBac® manufacturing process, BIO-tract®, soy free, gluten free, non-GMO, with Kiwifruit powder, a fruit superfood ingredient that helps probiotics to colonize, and supports digestion, colon health, and regularity. The tested formula contains 15 Billion Colony Forming Units per BIO-tract® pearl, which is equivalent to 225 Billion colony forming units (CFUs) of standard probiotic capsules.

Totally 20 surgeons were supplemented with *Hyperbiotics PRO-15 ADVANCED STRENGHT* (1 tablet/day) and 20 with placebo.

Statistical Analyses

Outcome measures of the exploratory study were analyzed with a *t-test* for paired samples for pre–post differences with time as the factor using Statistical Package for Social Sciences (SPSS for Windows, Version 11.5, Chicago, Ill) software, to detect significant differences between pre-test and post-test scores.

Results

We performed a study in which we tested the efficacy of patented probiotics formula on subjects with different levels of experience submitted to stressful situations such as surgical procedures of varying difficulty. To assess the effect of the probiotics we have considered several specific parameters such as salivary cortisol (sC), salivary Immunoglobulin A (sIgA), heart rate (HR) and systolic blood pressure (SBP). We then analyzed hormonal, immunological, and cardiovascular parameters.

We performed a randomized study using a computerized random number generator, which allowed us to select 40 subjects with different levels of experience. Surgeons were randomly grouped, according to their experience level, in three categories: senior, with more than 10 years of experience (N=14, mean age: 40±5); expert, between 5 and 10 years of experience (N=13, mean age: 30±3); junior, with less than 5 years of experience (N=13, mean age 30±4).

The subjects were divided into two groups: Group A, experimental group and group B, control.

Group A was made up of 7 juniors, 7 seniors and 6 experts and had to take one probiotics supplementation tablet (*Hyperbiotics PRO-15 ADVANCED STRENGTH*) a day for the duration of the study, while group B was made up of 6 juniors, 7 seniors and 7 experts and did not have to take the probiotics (pacebo).

The study lasted 10 weeks, during which the surgeons randomly carried out interventions of different difficulty that we classified as: easy (e.g. simple extraction surgery); intermediate (e.g. routine implantology); complex, which includes procedures of objective difficulty (e.g. sinus surgery and multiple implants insertion) (Table 1-2). We divided the 10 weeks into 3 times: T0 1 day before surgery, T1 within 1 hour of surgery and T2 (10 weeks after the first operation) within 1 hour of the last operation.

To analyze the levels of sC (Table 3-4 and Fig. 1-8) and sIgA (Table 5-6 and Fig. 9-16) the salivary samples of the surgeons were collected according to the circadian rhythm (in the morning), at the time T0 one day before the surgical procedure, at the time T1 then within an hour from the intervention and at time T2 then 10 weeks after T1 within one hour of the last operation.

Table I. Test Group

	Group A	
Name	**Level of experience**	**Difficult of interven-tions**
EA	Junior	Easy
CB	Junior	Easy
SS	Junior	Intermediate
FAR	Junior	Intermediate
ML	Junior	Complex
OP	Junior	Complex
AC	Junior	Complex
LI	Expert	Easy
AT	Expert	Easy
BG	Expert	Intermediate
CS	Expert	Intermediate
TR	Expert	Complex
AK	Expert	Complex
PI	Senior	Easy
ST	Senior	Easy
PA	Senior	Intermediate
FR	Senior	Intermediate
BJ	Senior	Complex
PS	Senior	Complex
BM	Senior	Complex

Table 2. Control Group

	Group B	
Name	**Level of experience**	**Difficult of interventions**
MM	Junior	Easy
AS	Junior	Easy
FP	Junior	Intermediate
BC	Junior	Intermediate
FG	Junior	Complex
MA	Junior	Complex
DC	Expert	Easy
MTP	Expert	Easy
SC	Expert	Intermediate
FS	Expert	Intermediate
DCO	Expert	Intermediate
PL	Expert	Complex
PP	Expert	Complex
CD	Senior	Easy
EF	Senior	Easy
UR	Senior	Easy
RM	Senior	Intermediate
PB	Senior	Intermediate
BP	Senior	Complex
OE	Senior	Complex

Table 3. Salivary cortisol levels at different times, group A.

sC Group A					
Name	**Level of experience**	**Difficult of interventions**	**T0 (ng/ml)**	**T1 (ng/ml)**	**T2 (ng/ml)**
EA	Junior	Easy	2,3	4,5	3,3
CB	Junior	Easy	5,1	7	6,2
SS	Junior	Intermediate	2,5	4,6	3,6
FAR	Junior	Intermediate	7,8	9,9	8
ML	Junior	Complex	4	7	6,3
OP	Junior	Complex	3,9	7,5	5,5
AC	Junior	Complex	5,4	7,9	6
LI	Senior	Easy	6	7	6,3
AT	Senior	Easy	4,6	7,5	6
BG	Senior	Intermediate	2,3	5,8	4,2
CS	Senior	Intermediate	4,1	7,1	5,6
TR	Senior	Complex	5	8	7,2
AK	Senior	Complex	2,8	5,3	4,4
PI	Senior	Easy	7	9	7,3
ST	Expert	Easy	5,5	8	6,6
PA	Expert	Intermediate	4	7,7	6
FR	Expert	Intermediate	8,7	11	8
BJ	Expert	Complex	4,9	7,5	6,9
PS	Expert	Complex	4,7	7,1	6,9
BM	Expert	Complex	3	5	4,6

Table 4. Salivary cortisol levels at different times, group B.

sC Group B					
Name	**Level of experience**	**Difficult of interventions**	**T0 (ng/ml)**	**T1 (ng/ml)**	**T2 (ng/ml)**
MM	Junior	Easy	2,6	4	3,8
AS	Junior	Easy	2,3	4,7	4
FP	Junior	Intermediate	5	7,4	7
BC	Junior	Intermediate	4,3	7	6,8
FG	Junior	Complex	3,9	7,6	6
MA	Junior	Complex	2,4	5,9	5
DC	Senior	Easy	5	6	6,1
MTP	Senior	Easy	3,8	5,2	4,6
SC	Senior	Intermediate	6	9	9
FS	Senior	Intermediate	5,6	8,4	7,6
DCO	Senior	Intermediate	7,6	10,2	10,1
PL	Senior	Complex	2,5	7	5
PP	Senior	Complex	4,3	7,9	7
CD	Expert	Easy	8	9	9
EF	Expert	Easy	3,6	5,1	4,9
UR	Expert	Easy	4,7	6	5,7
RM	Expert	Intermediate	6,9	10,1	10
PB	Expert	Intermediate	5	10	9,9
BP	Expert	Complex	7,9	12	10
OE	Expert	Complex	3,8	9	8,6

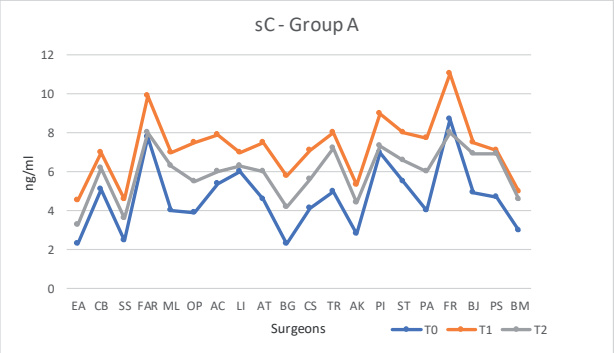

Fig. 1. Comparison of sC levels in Group A at 3 timepoints

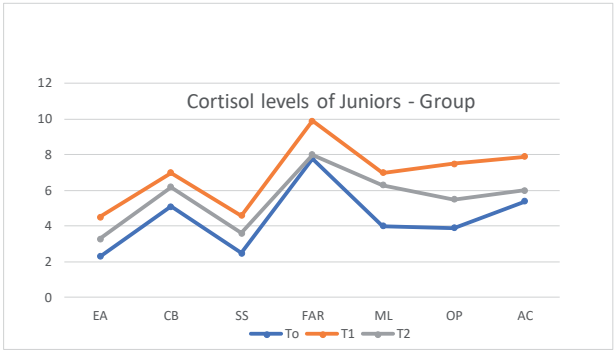

Fig. 3. Comparison of sC levels in Junior Group at 3 timepoints – Group A

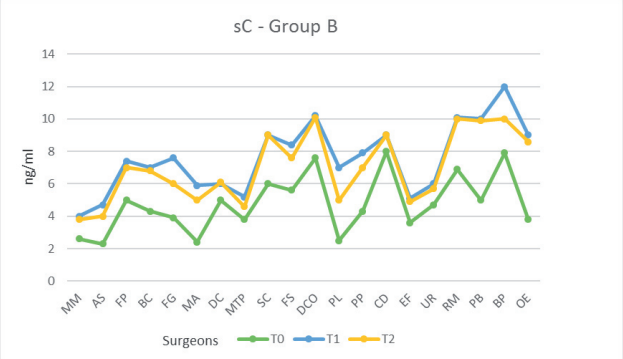

Fig. 2. Comparison of sC levels in Group B at 3 timepoints

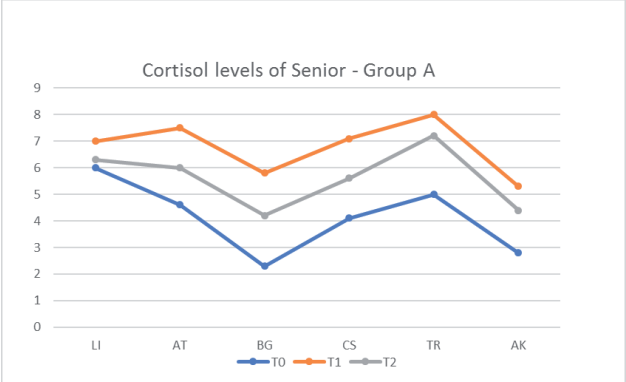

Fig. 4. Comparison of sC levels in Senior Group at 3 timepoints– Group A

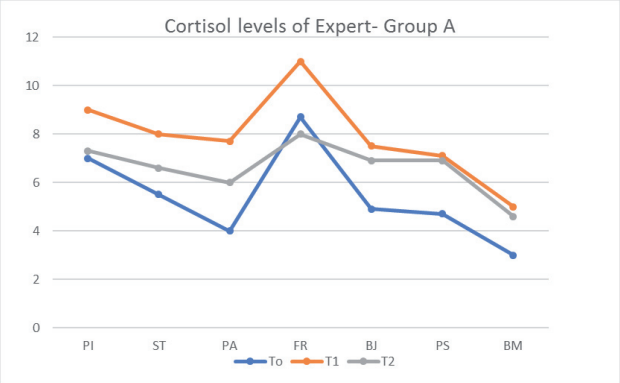

Fig. 5. Comparison of sC levels in Expert Group at 3 timepoints – Group A

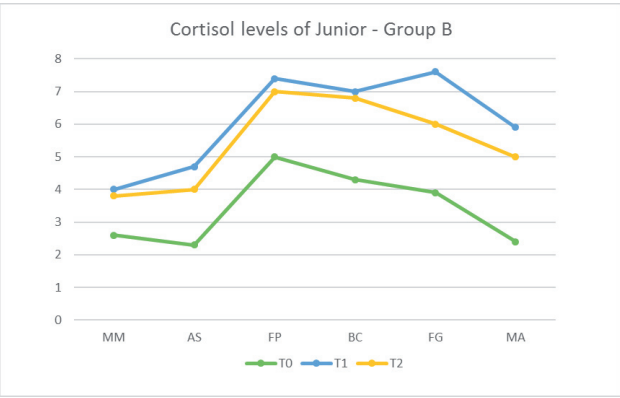

Fig. 6. Comparison of sC levels in Junior Group at 3 timepoints – Group B

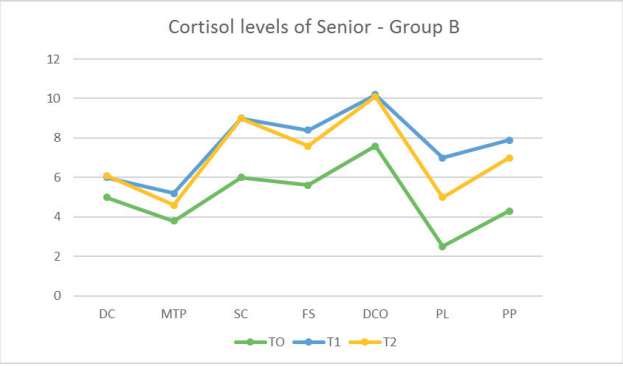

Fig. 7. Comparison of sC levels in Senior Group at 3 timepoints – Group B

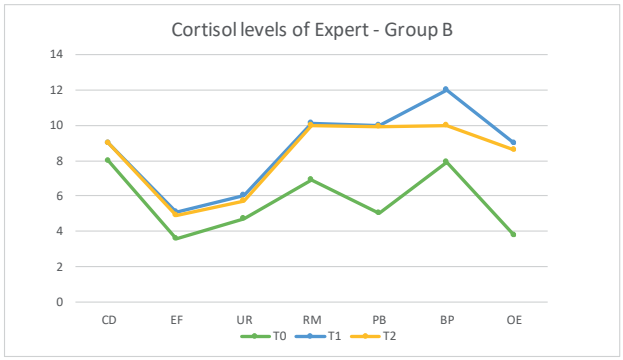

Fig. 8. Comparison of sC levels in Expert Group at 3 timepoints – Group B

Table 5. Salivary IgA levels at different times, group A

sIgA Group A					
Name	**Level of experience**	**Difficult of interventions**	**T0 (ng/ml)**	**T1 (ng/ml)**	**T2 (ng/ml)**
EA	Junior	Easy	21	22	23
CB	Junior	Easy	24	25	28
SS	Junior	Intermediate	49	50	50
FAR	Junior	Intermediate	33	34	35
ML	Junior	Complex	26	28	30
OP	Junior	Complex	43	44	46
AC	Junior	Complex	37	39	41
LI	Senior	Easy	49	49	50
AT	Senior	Easy	40	41	43
BG	Senior	Intermediate	38	38	41
CS	Senior	Intermediate	39	40	42
TR	Senior	Complex	49	50	51
AK	Senior	Complex	50	50	51
PI	Expert	Easy	46	47	49
ST	Expert	Easy	33	35	36
PA	Expert	Intermediate	29	30	32
FR	Expert	Intermediate	43	44	45
BJ	Expert	Complex	47	47	49
PS	Expert	Complex	25	26	28
BM	Expert	Complex	38	39	41

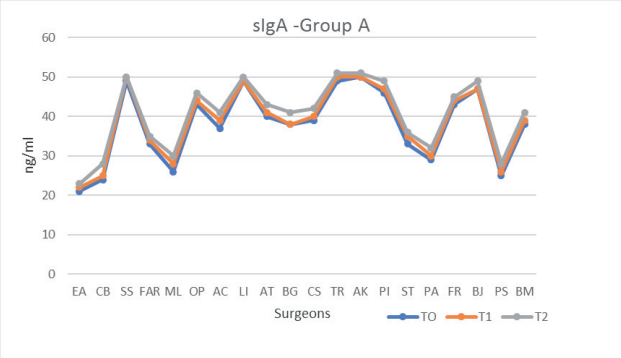

Fig. 9. Comparison of sIgA levels at 3 time points in Group A.

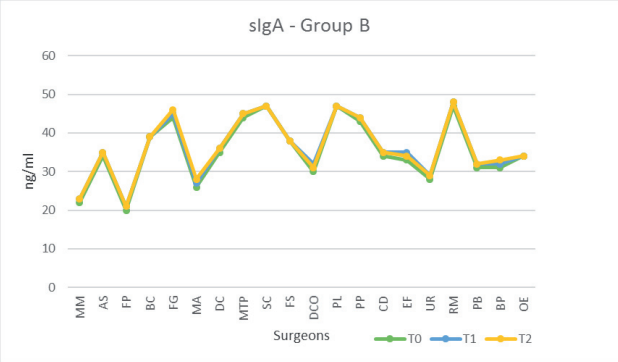

Fig. 10. Comparison of sIgA levels at 3 time points in Group B

From these general graphs, we can say that in group A (test) the variation of cortisol from T0 to T1 is relatively high due to the stress condition induced by the interventions, at T2 instead cortisol levels are relatively lower thanks to the prolonged action of probiotic which appears to lower cortisol even in stress conditions. In contrast, in group B (test) cortisol levels are high in T1 and T2 compared to T0 due to the stress condition that surgical operations generate in the surgeon. Evidence that the use of probiotics decreases salivary cortisol levels under stress.

The figures 1-8 show that in both groups cortisol levels at T1 and T2 are higher in expert compared to junior and senior. More precisely senior surgeons showed a remarkable stress management ability independently of the difficulty levels of the surgical procedure, whereas expert surgeons, rather than junior, showed quite high concentrations of sC in T1, independently of the difficulty of the procedure. We hypothesized that expert surgeons, being halfway between senior and junior, have not yet gained the confidence of the first, but are more aware of the possible risks of surgical failure compared to junior, thus this would induce an increase of sC.

Table 6. Salivary IgA levels at different times, group B

sIgA Group B					
Name	Level of experience	Difficult of interventions	T0 (ng/ml)	T1 (ng/ml)	T2 (ng/ml)
MM	*Junior*	*Easy*	22	23	23
AS	*Junior*	*Easy*	34	35	35
FP	*Junior*	*Intermediate*	20	21	21
BC	*Junior*	*Intermediate*	39	39	39
FG	*Junior*	*Complex*	44	45	46
MA	*Junior*	*Complex*	26	27	28
DC	*Senior*	*Easy*	35	36	36
MTP	*Senior*	*Easy*	44	45	45
SC	*Senior*	*Intermediate*	47	47	47
FS	*Senior*	*Intermediate*	38	38	38
DCO	*Senior*	*Intermediate*	30	32	31
PL	*Senior*	*Complex*	47	47	47
PP	*Senior*	*Complex*	43	44	44
CD	*Expert*	*Easy*	34	35	35
EF	*Expert*	*Easy*	33	35	34
UR	*Expert*	*Easy*	28	29	29
RM	*Expert*	*Intermediate*	47	48	48
PB	*Expert*	*Intermediate*	31	32	32
BP	*Expert*	*Complex*	31	32	33
OE	*Expert*	*Complex*	34	34	34

The figures 9-16 show the variations in sIgA levels in the all groups at 3 times. In both groups, there is an increase in T1 levels compared to T0, because stress induces an increase in immunoglobulin levels. In both groups, the differences at different times are not substantial,

but it can be noted in the test group (A) how the immunoglobulin levels are higher this because the prolonged use of probiotics induces an increase in the number of cells that produce IgA.

From the comparative graphs, it can be seen that the experts and seniors have higher levels of IgA, in particular, seniors who are older present an additional element in stress

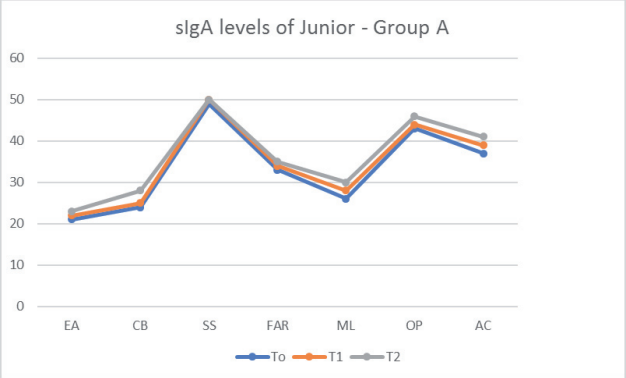

Fig. 11. Comparison of sIgA levels in Junior Group at 3 timepoints – Group A

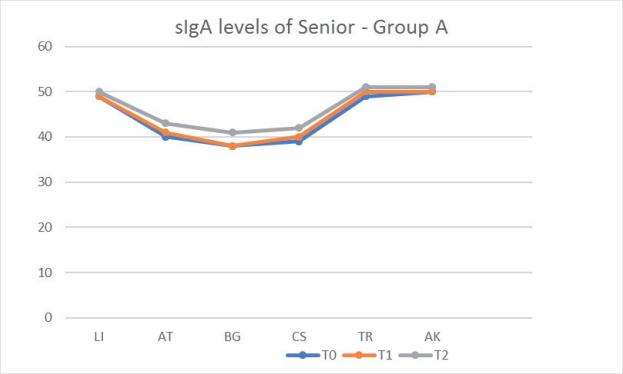

Fig. 12. Comparison of sIgA levels in Senior Group at 3 timepoints – Group A

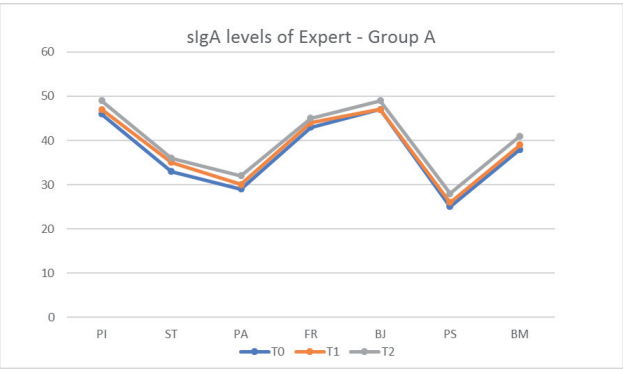

Fig. 13. Comparison of sIgA levels in Expert Group at 3 timepoints – Group A

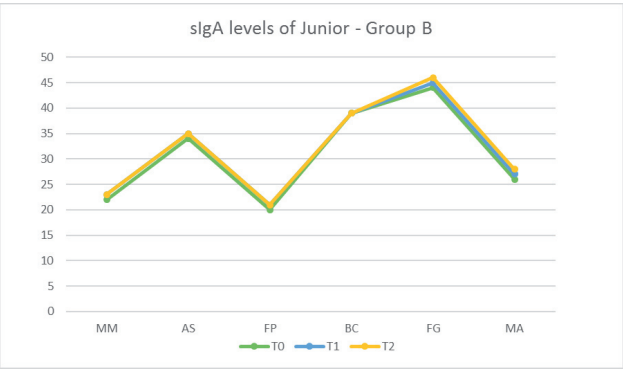

Fig. 14. Comparison of sIgA levels in Junior Group at 3 timepoints – Group B

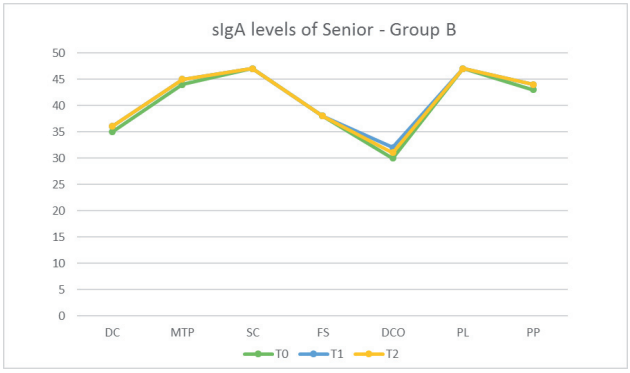

Fig. 15. Comparison of sIgA levels in Senior Group at 3 timepoints – Group B

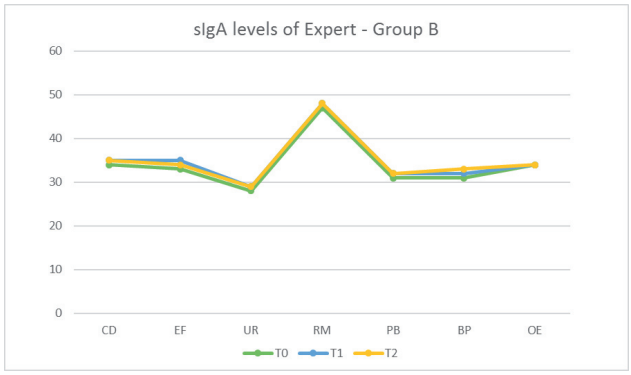

Fig. 16. Comparison of sIgA levels in Junior Group at 3 timepoints – Group B

conditions that can be defined as stress inflammation. The subjects above all at the gastrointestinal level suffer a lot from the stress that induces inflammatory processes which obviously need more immunoglobulins to fight them.

The results highlighted in these (Fig. 17-18), show that the number of heartbeats/ minute (Tables 7-8) is slightly raised in all surgeons at T1 and T2, or the times about to the operation. The same thing happens on SBP (Tables 9-10) (Fig. 19,20). This output allows us to understand how stress can induce an increase in these cardiovascular parameters, but they are not modified by the use of probiotics.

Table 7. HR at different times, group A.

HR – Group A					
Name	**Level of experience**	**Difficult of interventions**	**T0 Beats/min**	**T1 Beats/min**	**T2 Beats/min**
EA	*Junior*	*Easy*	71	73	73
CB	*Junior*	*Easy*	65	66	66
SS	*Junior*	*Intermediate*	77	78	78
FAR	*Junior*	*Intermediate*	62	64	63
ML	*Junior*	*Complex*	70	71	70
OP	*Junior*	*Complex*	66	67	67
AC	*Junior*	*Complex*	80	81	82
LI	*Senior*	*Easy*	81	82	82
AT	*Senior*	*Easy*	78	80	81
BG	*Senior*	*Intermediate*	79	80	80
CS	*Senior*	*Intermediate*	69	71	71
TR	*Senior*	*Complex*	66	69	70
AK	*Senior*	*Complex*	80	81	81
PI	*Expert*	*Easy*	77	78	78
ST	*Expert*	*Easy*	65	66	66
PA	*Expert*	*Intermediate*	61	63	64
FR	*Expert*	*Intermediate*	79	80	80
BJ	*Expert*	*Complex*	80	81	81
PS	*Expert*	*Complex*	80	81	81
BM	*Expert*	*Complex*	78	79	80

Table 8. HR at different times, group B.

HR – Group B					
Name	**Level of experience**	**Difficult of interventions**	**T0 Beats/min**	**T1 Beats/min**	**T2 Beats/min**
MM	*Junior*	*Easy*	67	68	69
AS	*Junior*	*Easy*	79	80	80
FP	*Junior*	*Intermediate*	78	79	78
BC	*Junior*	*Intermediate*	80	80	81
FG	*Junior*	*Complex*	66	67	67
MA	*Junior*	*Complex*	72	73	73
DC	*Senior*	*Easy*	75	76	76
MTP	*Senior*	*Easy*	75	75	76
SC	*Senior*	*Intermediate*	69	70	70
FS	*Senior*	*Intermediate*	79	80	79
DCO	*Senior*	*Intermediate*	80	80	80
PL	*Senior*	*Complex*	67	69	68
PP	*Senior*	*Complex*	71	73	72
CD	*Expert*	*Easy*	74	75	75
EF	*Expert*	*Easy*	78	79	79
UR	*Expert*	*Easy*	79	80	80
RM	*Expert*	*Intermediate*	68	69	69
PB	*Expert*	*Intermediate*	69	70	70
BP	*Expert*	*Complex*	80	80	80
OE	*Expert*	*Complex*	77	79	78

Table 9. SBP at different times, group A.

SBP – Group A					
Name	**Level of experience**	**Difficult of interventions**	**T0 mmHg**	**T1 mmHg**	**T2 mmHg**
EA	*Junior*	*Easy*	110	113	112
CB	*Junior*	*Easy*	118	119	120
SS	*Junior*	*Intermediate*	124	126	125
FAR	*Junior*	*Intermediate*	121	121	122
ML	*Junior*	*Complex*	126	128	125
OP	*Junior*	*Complex*	125	128	129
AC	*Junior*	*Complex*	130	131	131
LI	*Senior*	*Easy*	120	121	121
AT	*Senior*	*Easy*	137	137	137
BG	*Senior*	*Intermediate*	123	128	126
CS	*Senior*	*Intermediate*	141	143	144
TR	*Senior*	*Complex*	129	132	131
AK	*Senior*	*Complex*	119	120	120
PI	*Expert*	*Easy*	120	121	121
ST	*Expert*	*Easy*	118	119	120
PA	*Expert*	*Intermediate*	131	132	131
FR	*Expert*	*Intermediate*	125	126	127
BJ	*Expert*	*Complex*	121	125	124
PS	*Expert*	*Complex*	117	120	119
BM	*Expert*	*Complex*	120	122	123

Table 10. SBP at different times, group B.

SBP – Group B					
Name	**Level of experience**	**Difficult of interventions**	**T0 mmHg**	**T1 mmHg**	**T2 mmHg**
MM	*Junior*	*Easy*	121	122	122
AS	*Junior*	*Easy*	133	134	134
FP	*Junior*	*Intermediate*	128	129	129
BC	*Junior*	*Intermediate*	120	123	121
FG	*Junior*	*Complex*	118	120	119
MA	*Junior*	*Complex*	132	133	133
DC	*Senior*	*Easy*	140	141	143
MTP	*Senior*	*Easy*	135	136	137
SC	*Senior*	*Intermediate*	126	128	128
FS	*Senior*	*Intermediate*	128	130	130
DCO	*Senior*	*Intermediate*	119	120	120
PL	*Senior*	*Complex*	121	122	122
PP	*Senior*	*Complex*	123	124	123
CD	*Expert*	*Easy*	132	133	133
EF	*Expert*	*Easy*	138	140	139
UR	*Expert*	*Easy*	120	123	121
RM	*Expert*	*Intermediate*	131	133	134
PB	*Expert*	*Intermediate*	127	128	128
BP	*Expert*	*Complex*	120	122	123
OE	*Expert*	*Complex*	123	125	124

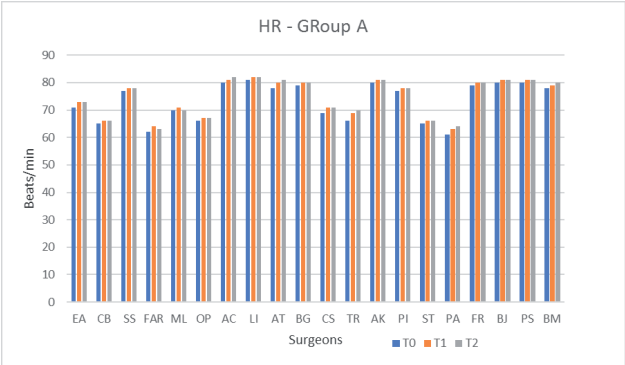

Fig. 17. Comparison of HR levels at 3 time points in Group A

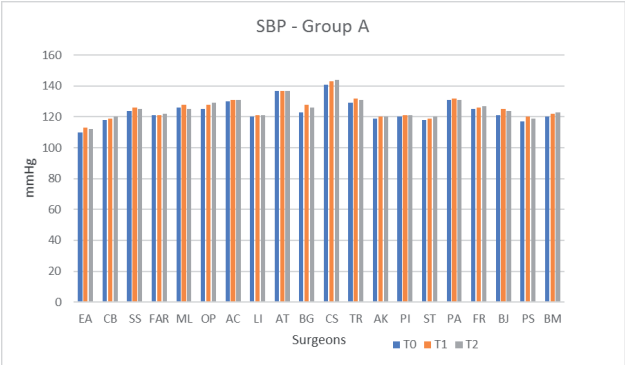

Fig. 19. Comparison of SBP levels at 3 time points in Group A

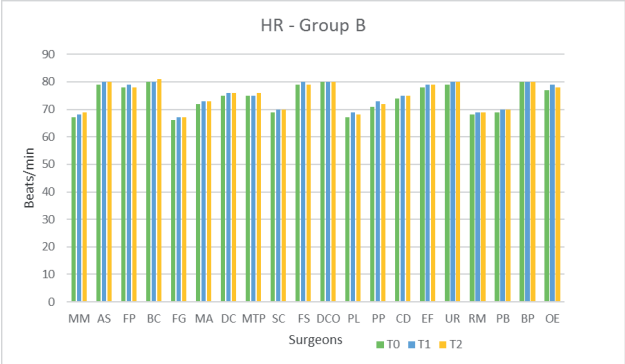

Fig. 18. Comparison of HR levels at 3 time points in Group B

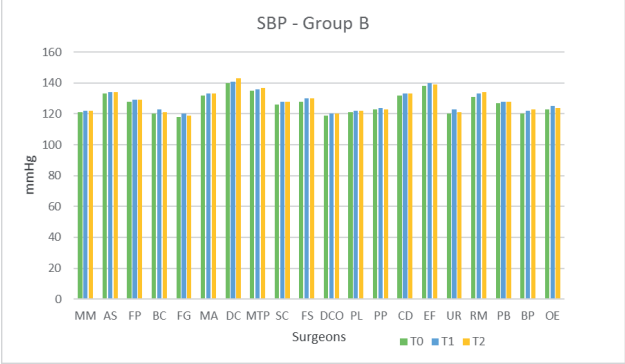

Fig. 20. Comparison of SBP levels at 3 time points in Group B

Discussion

Psychological stress is an almost ubiquitous negative condition. Studies have found that probiotics can relieve this stress condition, particularly alleviating negative emotions and improving cognitive conditions (16). A significant increase in emotional health issues, such as depression, stress, and anxiety, has been recently reported. Stress has a great influence on the immune system, altering the concentrations of secretory IgA and stress markers on a salivary level such as cortisol (17-19). Probiotics have different effects on immunomodulation, in fact, by administering probiotics to stressed subjects, it was possible to see how these products act directly on the production of IgA and have minimal direct effects on cortisol. It can, therefore, be stated that probiotics have direct effects on the immune system but less visible effects on stress markers (20). In a study carried out in April 2019, the probiotic Lactobacillus plantarum DR7 was administered to some patients with high-stress levels to assess the effects of the probiotic on this condition of patients. The results obtained indicate that the DR7 satisfies the requisites sought because it allows controlling the cortisol levels also reducing the level of pro-inflammatory cytokines. It is therefore thought that this probiotic could be used as a natural strategy to improve psychological functions and patients' health as it improves the serotonin pathway and stabilizes the dopamine pathway (21). Maintenace of health is important in differet conditions, especially stress conditions that can lead also to cancer (22-30) or realted diseases (30-39). Our data indicate that 10 weeks of probiotic integration allow the alteration of some stress-related physiological parameters in oral surgeons with different degrees of surgical experience. Surgeons, in general, are subjected to periods of high stress, especially on a mental level, which can negatively influence not only their work activities but also their quality of life.

The parameters taken into consideration were hormonal, immunological, and cardiovascular parameters. The integration of probiotics has not provided any beneficial effect on the cardiovascular parameters, which have maintained overlapping values at different times and in different subjects, considering that the stress condition to which surgeons are subjected depending on years of experience tends to cause an increase of heart rate (HR) and systolic blood pressure (SBP). Stress increases the salivary cortisol defined, in fact, as "stress hormone". It is obvious that cortisol levels also increase based on the experience of the surgeon, on the type of operation to be performed but also by how the subject is confronted with activities. On this parameter the administration of probiotics had effects on the treated group compared to placebo, inducing a significant lowering. Also at the immune level, probiotics have a positive impact, inducing an increase in levels of salivary Immunoglobulin A (sIgA) in the treated group compared to the control group, in favor of the fact that probiotics under stress conditions, where there is also an impact important on inflammatory processes, it

acts on the regulation of some components of the immune and hormonal response. The improvement of stress-related parameters could impact the perception of work-related pathologies in surgeons, as well as in other healthcare professionals (40-44). Our work may be the scientific proof of the concept that work-related stress should be managed with a healthy life and a proper diet.

Conclusions

Even though the limitations of our study, associated with the study design and the low sample size, our results highlighted that a ten-week intake of selected probiotics represents a useful approach in occupational stress-related procedures. Nevertheless, further clinical trials need to be performed on a larger sample and for a longer period of treatment (included a wash-out period) before definitive conclusions can be made.

Conflicts of Interest: The authors declare no conflict of interest.

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