Heliyon 10 (2024) e35495

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Combined effects of a Mediterranean diet and respiratory muscle training on higher education woodwind musicians: A randomized controlled trial

Carlos Sanchis [a], Marcos Plaza [b], Irene Checa [c,*], Cristina Monleón [a]

[a] Catholic University of Valencia "San Vicente Mártir", Faculty of Physical Education and Sports Sciences, Valencia, Spain
[b] Doctoral School, Catholic University of Valencia "San Vicente Mártir", Faculty of Physical Education and Sports Sciences, Valencia, Spain
[c] Department of Developmental and Educational Psychology, Faculty of Psychology and Speech Therapy, University of Valencia, Valencia, Spain

ARTICLE INFO

Keywords:
Mediterranean diet
Respiratory training
Respiratory fatigue
Music performance
Stress
And emotional intelligence
Windwood musicians

ABSTRACT

A two-factor within subjects and randomized controlled was conducted with three groups (two experimental and one control) to explore the effects of the Mediterranean diet and respiratory muscle training on ventilatory fatigue, stress, and emotional performance of woodwind musicians. 70 students from the Valencia Conservatory of Music were recruited and randomized into three groups: respiratory training group + nutrition program (RTG; $n = 17$), control group (CG; $n = 35$) and nutrition program group (NPG; $n = 18$). The nutritional program was based on Mediterranean a diet. Body composition, emotional intelligence, physiological stress and ventilatory response were assessed for all groups before and after intervention. Mixed ANOVA showed main effects of diet and training interventions on emotional attention ($F = 8.042$; $p = 0.006$), clarity ($F = 9.306$; $p = 0.003$), repair ($F = 5.527$; $p = 0.022$), Forced-Expiratory-Volume ($F = 30.196$; $p < 0.000$) and Forced-Vital-Capacity ($F = 21.052$; $p < 0.000$), with both interventions improving emotional intelligence and ventilatory variables. Bonferroni post-hoc analysis revealed significant differences of RTG and CG for emotional attention (MD = 4.60; $p = 0.023$), comprehension (MD = 5.734; $p = 0.005$), repair (MD = 8.576; $p < 0.000$), FEV1 (MD = 0.862; $p = 0.005$), and FCV (MD = 1.608; $p < 0.001$); with similar results when comparing NTG and CG: emotional attention (MD = 4.156; $p = 0.041$), comprehension (MD = 4.473; $p = 0.033$), repair (MD = 6.511; $p = 0.001$), Forced-Expiratory-Volume (MD = 1.608; $p < 0.001$), and Forced-Vital-Capacity (MD = 1.183; $p < 0.001$). No significant effects of experimental groups were observed for physiological stress variables ($p > 0.05$). This results suggests that respiratory training enhances emotional intelligence and lessens respiratory fatigue in musicians, and a combination of a Mediterranean diet and respiratory muscle training further boosts emotional intelligence, albeit with limited impact on physiological stress. This study represents a novel investigation into the approach by dietary interventions and respiratory muscle training in wind musicians since there are no studies that analyze it.

* Corresponding author.
E-mail addresses: carlos.sanchis@ucv.es (C. Sanchis), marplaca@mail.ucv.es (M. Plaza), irene.checa@uv.es (I. Checa), cristina.monleon@ucv.es (C. Monleón).

https://doi.org/10.1016/j.heliyon.2024.e35495
Received 7 March 2024; Received in revised form 19 June 2024; Accepted 30 July 2024
Available online 31 July 2024

1. Introduction

Current societal lifestyles and rhythms of life have led to diseases that affect the quality of life, even though the years of life expectancy have increased [1], highlighting the relevance of food and individualized diets on health (physiological, physical, psychological, emotional, and social) [2,3]. However, few studies have examined the impact of diet and nutrition on the health of professional musicians or musician students, with most of the research being centered on the effects of educational programs on the postural health of guitarists and instrumentalists [4,5] or musculoskeletal disorders [6,7].

Nevertheless, musicians' health, including nutrition, mental skills, sleep [8] stress, and musculoskeletal performance [9], generally shows certain deficiencies that must be treated holistically, as reported in the literature [10–13].

From a nutritional point of view, health implies a varied and balanced diet, where musicians must have the right proportions according to their individual needs, due to the stressful demands of performances, as well as the various places where they perform [14]. In this context, the Mediterranean diet combines different elements, including culture, physical exercise, diet, and even the way of cooking [15], which has been widely related to health benefits at the metabolic, cardiovascular (including autonomic balance), or overall well-being level [15–19], reducing type II diabetes [17,20] and preventing obesity when combined with physical activity [21].

Moreover, literature has shown that Mediterranean diet is related to lower levels of stress or depression in superior-education students [22] and lower levels of emotional clarity in elementary school students [23–26]. Additionally, compelling evidence exists about the correlation between proper breakfast and better cognitive function and academic performance in children and adolescent populations [27], and a well-established relationship exists between Mediterranean diet adherence and health status, body composition (visceral fat), and physical performance in adults [28,29]. Notably, current evidence suggests that autonomic balance, measured using Heart Rate Variability (HRV), is related to general health [19,30] and is considered a good predictor of all-cause cardiovascular mortality [31], easy to control, and useful for health and exercise guidance [31]. Some studies [31–34], analyzed HRV response in trained musicians to measure biofeedback relaxing effects [32], describe autonomic balance changes with technical demands and music expertise [34] and during stressful musical performances [33]. However, to our knowledge, the influence of the Mediterranean diet on academic performance, emotional status, HRV, and body composition has not been investigated in superior-musician students.

Although music performance is multifactorial, emotional intelligence and emotional management are potent modulators [35] that change performance perception. Emotional intelligence can be evaluated using specific questionnaires, such as the Trait Meta-Mood Scale on Emotional States (TMMS-24) [36], which consists of a trait scale that assesses the metacognition of emotional states, and more specifically, the ability to be aware of one's own emotions, as well as the ability to regulate them [37]. This type of questionnaire has been previously used to explore Mediterranean diet effects on emotional intelligence of and athletes [38], and of primary [39], elementary [25,40] and university students [41], with all of them showing a positive association of diet and healthy habits (including physical activity) and emotional clarity [23,39] or emotional attention [25,39]. However, no study has analyzed changes in TMSS in musicians with an interventional study. Moreover, there's a lack of knowledge about diet influence on emotional performance of superior music education students.

In addition, physical fitness is a major determinant of musical performance, as prolonged instrumental practice or performance during concerts usually produces high levels of physical stress with increased perception of effort (RPE), respiratory rate, and elevated heart rate (HR) [42], thus producing fatigue and a possible reduction in overall performance. As a result, general well-being strategies like diet and training, have been marked as key to improving overall performance in higher education music students [43] or improve emotional intelligence, as described before. In fact, strength and endurance training [44], yoga and physical therapy [45] or specific rehabilitation exercises program [46] have shown to improve music performance or mitigate negative musculoskeletal limitations of musicians.

Particularly, pulmonary function and training in wind instrument players is a topic of special interest. Indeed, an increase in ventilatory muscle strength is considered an advantage for professional musicians, who might show greater pulmonary function due to repeated expirations and proper breath control, typical of "blowing" musicians [47]. Generally, breathing exercises prioritizing diaphragmatic activation and combining supine and prone position are recommended to improve lung capacity of musicians [48]. In contrast, respiratory muscle training effects (using specific devices) in healthy populations have been widely studied [49], with a recent meta-analysis proving that breathing devices (*e.g.* TrainingMask® and POWERbreathe®) can improve dyspnea, ventilatory efficiency, maximum inspiratory pressure, maximal oxygen consumption, and muscle recruitment patterns by administering a $\geq$15 % resistive external load [50–52]. Despite its potential benefits, few studies have analyzed the effects of respiratory muscle training in the music population [53,54]. For example, Dries et al. [55] applied training to wind instrument musicians (saxophone players) and showed an increase in muscle strength and peak flow rates. How respiratory training affects to a non-wind musician remains to be investigated.

Moreover, respiratory muscle training, diet, and adequate nutrition (*e.g.* Mediterranean diet) have been related to chronic pulmonary disease prevention and treatment, by improving lung function and cognition [56–58] and increasing parasympathetic activation through HRV changes, and have the potential to prevent performance reduction in adult musicians, increase academic performance over time, provide valuable information for optimizing musician performance, or be able to adapt instrumental practice to excessive stress or of the musician [59,60].

To the best of our knowledge, no prior study has comprehensively examined the synergistic effects of dietary interventions and respiratory muscle training on pulmonary function, heart rate variability (HRV), and academic performance in wind musicians.

In this sense, the research question lies in: What are the effects of a healthy Mediterranean diet combined with respiratory muscle training on physiological stress indicator, emotional intelligence, and respiratory fatigue in wind musicians during higher artistic education?

Consequently, we designed a study to analyze the effects of a healthy Mediterranean diet and respiratory muscle training on anthropometric measures, HRV, and academic and emotional performance in higher artistic education specialized in oboe, clarinet, flute, and bassoon instruments. Based on this, we propose the following hypothesis.

H1. Participants who follow a Mediterranean diet with respiratory work will show better scores in physiological stress indicators after the intervention than the other groups.

H2. Participants who follow a Mediterranean diet with respiratory work will show better scores in emotional intelligence after the intervention compared to the other groups.

H3. : The participants who follow a Mediterranean diet with respiratory work will reveal better scores in respiratory fatigue after the intervention than the other groups.

2. Materials and methods

2.1. Study design

A two-factor within-subjects and randomized controlled trial was designed to establish the effects of Mediterranean-diet and respiratory muscles training on academic musical performance, body composition, HRV, and ventilatory performance before, during, and after the intervention.

2.2. Participants

70 students (32 girls and 38 boys) from different music conservatories in the Valencian Community and different specialties (oboe, clarinet, flute, and bassoon) (age: mean = 25; ± *SD* = 11.4), were selected and enrolled in this study by signing an informed consent form. The eligibility criterion was that subjects must be active musicians undergoing academic training in a higher artistic education conservatory during the 2022–2023 academic year. Exclusion criteria included participants who did not follow diet or respiratory training instructions and those who did not complete all the measurements before, during, or after the intervention (see Fig. 1).

The sample size was calculated from similar socio-demographic data of academic-age musicians [21,61], collecting data on expected standard deviation 44, sensitivity 31.2, equilibrium factor 1, expected loss fraction of 10 % and a desired statistical power of 80 % were used to calculate the total sample size. The baseline body composition and anthropometric characteristics of the participants are presented in Table 1.

Therefore, 70 students were randomized on October ’22 into three groups using SPSS Statistics software (IBM): two experimental groups and one control group. Thereby, 18 students (5 males and 13 females) were part of the Respiratory Training Group (RTG), and 17 students (7 males and 10 females) were assigned to the Nutritional Program Group (NPG), with the experimental group sample of 35 participants (12 males and 23 females) matching the same number of individuals in the Control Group sample (CG, 18 males and 17 females). The CG did not receive any nutritional intervention or respiratory training. RTG and NPG followed a nutritional follow-up program (see Table 2), for 12 weeks. In addition to the nutritional program, RTG completed a 12-week respiratory training program using a respiratory muscle-training device.

2.3. Interventions

2.3.1. Nutrition program

A Mediterranean-based nutrition program was designed to for RTG and NPG groups in order to analyze its effects on emotional intelligence, spirometry values and HRV of conservatory students, and its interaction with respiratory muscle training. An individualized 12-week nutrition program was created for each participant, consisting in a weekly document with daily details of nutrients and food intake, and was complemented with 12 online educational lectures to ensure program comprehension. Online educational lectures included the following topics: diet and healthy food, pre-concert nutrition, myths, and false beliefs.[1] 12 in-person control sessions took place at the multi-purpose hall of the Valencia Conservatory of Music for each participant, including an initial (week 1) and final (week 12) evaluation sessions. The program was designed and controlled by a professional dietitian (collegiate number CV00710) with a degree in pharmacy and professional musician. Individual weekly food intake and distribution was calculated using a food exchange list developed by Marques-Lopez et al. [62] and following dietary guidelines of the Spanish Society of Community Nutrition [63,64], where 21 % of the energy was derived from proteins, 29 % from lipids (all of which were derived from the intake of extra virgin olive oil), and the remaining 50 % from carbohydrates, and the latter being mainly divided into fruit, vegetables, and greens [65]. An example of weekly energy distribution using the exchange system is presented in Table 2. Energy expenditure was individualized initially, and adjusted every week, using a validated estimation formula for Resting Energy Expenditure (REE) [66]. De la Cruz et al. estimation formula has been validated for healthy Spanish population and calculates REE based on age and Body Weight (BW). BW was measured by a BF511 OMRON scale (Healthcare, Netherlands) [67,68]. Program adherence was assessed by assistance to each control sessions (100 % attendance) and online lectures (68 % attendance).

[1] Actual presentations are available in Spanish at: https://drive.google.com/drive/u/1/folders/1TlqdRbdgx_PYwDt0OGVZIVpLcGVFqz2u.

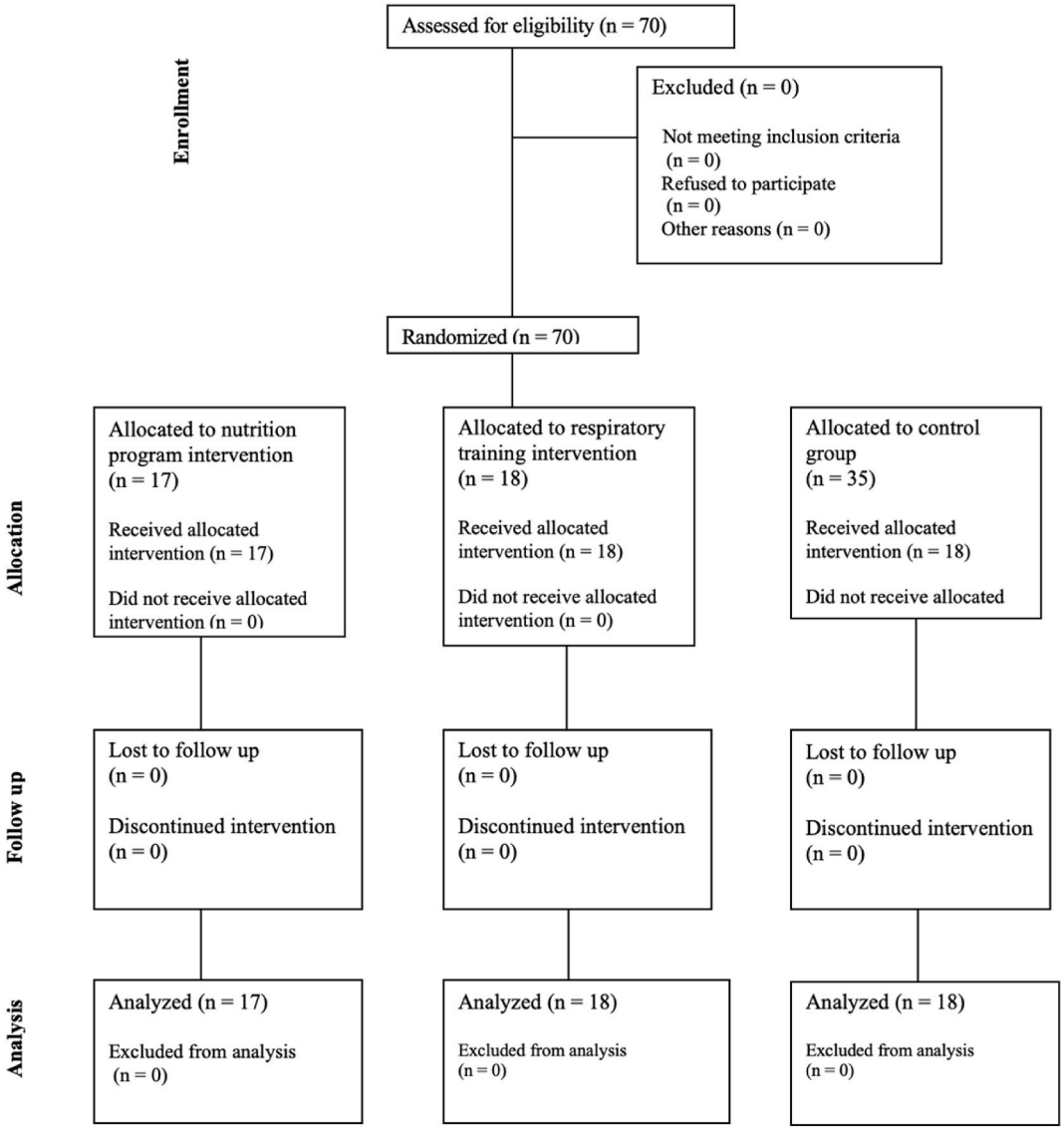

Fig. 1. A flow diagram following CONSORT guidelines.

Table 1
Initial anthropometric data (presented as $M \pm$ SD).

	CG	RTG	NPG
Sample size	35	17	18
Age (years)	25 ± 11.4	28 ± 9.2	23 ± 6.7
Weight (kg)	68 ± 13.4	78 ± 17.4	72 ± 15.6

Note. CG = control grup. RTG = respiratory training group. NPG = nutrition program group.

2.3.2. Respiratory muscle training

A respiratory training program was designed to analyze its interaction with the Mediterranean-based nutrition program to modify emotional intelligence, ventilatory performance and HRV on conservatory students. Participants in NPG received a 12-week detailed respiratory training protocol and a POWERbreathe Classic device (POWERbreathe, Spain) to complete the intervention. The respiratory training program was designed and controlled by two professional sport-coaches and sport-scientists with more than 10 years of experience in personal training, following recent evidences [51,52] and specific guidelines for musicians [69]. Within the 12-week training protocol, the participants were required to complete, daily, 2 × 30 dynamic inspiratory efforts through the device, with a 15 min rest period in between. Training sessions were performed by each participant at home, autonomously, with a nose clip.

Table 2
Dietary characteristics, exchange system and food groups of RTG and NPG study subjects.

EXCHANGE (E)	BREAKFAST	LUNCHEON	LUNCH	SNACK	DINNER	BREAK
Milk products (2)	1	0,5	0	0,5	0	0
Vegetables (4)	0	0	2	0	2	0
Fruits (4)	0	1	1	1	1	0
Flour (9)	3	0	3	0	3	0
Protein foods (4)	0	0	2	0	2	0
Fatty foods (3)	1	0	1	0	1	0
Total energy expenditure	2600 Kcal					
Energy diet	1800 Kcal					
Caloric distribution	Proteins (20 %): 360 Kcal or 9 E Lipids (30 %): 540 Kcal or 6 E Carbohydrates (50 %): 900 Kcal or 22.5 E					

Note. Food intake adjusted for 1800 kcal/day. The numbers in the table are the number of exchanges in each food group. One exchange = amount of food containing 10 g of one of the macronutrients (protein, lipids, or carbohydrates). E = exchange. Kcal = kilocalories.

Intensity was controlled by a 0-10 adjustment dial on the device, starting at "Level 3" for the first four weeks, increasing to "Level 5" during the fifth to eighth week, and settling at "Level 7" during the last four weeks of the intervention. Gradual increases in respiratory resistance have shown to improve pulmonary capacity and volume, inspiratory muscle force, and reduce the sensation of dyspnea and muscle fatigue in highly trained athletes [65,70].

2.4. Measures

2.4.1. Emotional intelligence

Emotional intelligence, as primary outcome of this research, was assessed with the Spanish-validated questionnaire Trait-Meta-Mood Scale 24 (TMMS-24) [36]. This questionnaire has 24 terms rated on a five-point Likert scale, and assess three different dimensions (emotional attention, emotional clarity, and emotional repair). Dimensions and overall score were calculated following previous research [24].

2.4.2. Spirometry

Forced Expiratory Volume at the first second (FEV1) and Forced Vital Capacity (FCV) were analyzed, as primary outcomes of the study, with a portable spirometer (SP10 mobile spirometer, Contect Medical Systems, Germany). Portable spirometry has been used in previous studies to monitor lung function or respiratory sports performance [71–73]. Following Waters [74] and Mgbemena et al. [71,72], during the spirometry each participant was asked to exhale three times through CONTEC SP10 mobile device.

2.4.3. Heart rate variability

Resting HRV values were registered for each participant, as secondary outcomes, to assess changes in physiological stress produced by NTG and RTG interventions. H7 polar sensors and chest bands (Polar Inc., Kempele, Finland) were connected to EliteHRV mobile application (ELITE Inc., United States). Therefore, a RR intervals analysis and filtering was performed with EliteHRV app to calculate Root Mean Square of Standard Deviation (rMSSD), Low Frequency (LF), High Frequency (HF), and mean resting Heart Rate (HR) (for a review of HRV derivate and its definition see Ref. [75]. HRV analysis has proven to be a valid and reliable method [76] for assessing autonomic nervous system balance, and has shown to be useful in high-performance and high-demanding contexts, like professional sports, by allowing coaches to control central nervous system fatigue, and optimize training load [31,77–80]. A 1-min short, seated, and app-guided breathing pattern (15 breaths/minute) measurement was used for time efficiency (for a review, see Ref. [81].

2.5. Procedure

2.5.1. Initial and final assessment

Initial measurements took place on October '22 at the multi-purpose hall of the Valencia Conservatory of Music between 9.00 a.m. and 15.00 p.m. During the first session, participants from all groups received detailed information about the study design and procedures, signed the informed consent to participate, and filled in the TMMS-24 questionnaire. During the next three natural days, at 9.00 a.m., HRV and ventilatory response at rest (spirometry) were assessed for all groups in the same room, where temperature and humidity were controlled by a TRECEABLE-certified mobile thermohygrometer [80] to stay between 20 and 22 °C and 43–45 % humidity. HRV measurement, ventilatory response (spirometry) and TMMS-24 questionnaire were repeated at 12th week, following the same protocol described before. TMMS-24 questionnaire was administered only on two occasions, since when evaluating a psychological variable greater stability is assumed and two measures are considered more appropriate.

2.5.2. Intervention period

After the initial measurements, the RTG and NPG were enrolled in the 12-week nutrition program described before (from October '22 to January '23), complemented by 12 online educational sessions (live and recorded). Moreover, RTG initiated the 12-week

respiratory muscle training program. On the sixth week of the intervention period, HRV and ventilatory response measurement protocol described before was repeated.

2.6. Data analysis

To test hypothesis 1, four mixed ANOVA was performed, considering the main effect and the interaction of the within-subjects' variable (with three levels: pre-intervention, during intervention, and post-intervention) and the between-subjects' variable (RTG, NPG, and CG) in four dependent variables: rMSSD, LF, HF and HR.

To test hypothesis 2, three mixed ANOVA was performed, considering the main effect and the interaction of the within-subjects' variable (with two levels: pre-intervention, and post-intervention) and the between-subjects' variable (RTG, NPG, and CG) in three dependent variables: emotional attention, emotional clarity, and emotional repair.

To test hypothesis 3, two mixed ANOVA was performed, considering the main effect and the interaction of the within-subjects' variable (with three levels: pre-intervention, during intervention, and post-intervention) and the between-subjects' variable (RTG, NPG, and CG) in two dependent variables: FEV1 and FCV.

In case the interaction effect was significant, repeated measures unifactor ANOVAs with Bonferroni post-hoc tests were performed to test the effect of the intervention. The assumptions of normality and sphericity were checked. In the case of non-sphericity, the Greenhouse-Geisser correction was applied. Effect sizes were reported in terms of partial eta^2 (η_p^2). The criterion established by Cohen (1988) for the interpretation of effect sizes has been taken, which considers $\eta_p^2 = 0.01$ (d = 0.2) a small effect size, $\eta_p^2 = 0.059$ (d = 0.5) medium and $\eta_p^2 = 0.138$ (d = 0.8) large.

The analyses were conducted using the SPSS statistical package (IBM version 20.0, SPSS Inc., Chicago, IL, USA). For all the analyses, the level of significance was $p < .05$.

3. Results

3.1. Physiological stress indicators

Table 3 shows the results of the mixed ANOVAs performed on the four variables related to physiological stress. In all of them, the Mixed ANOVA revealed simple effect of time and no significant interaction between Group and time, and therefore physiological stress obtained did not differ between the time for the three studied groups.

3.2. Emotional intelligence

Table 4 shows the results of the mixed ANOVAs performed on the three variables related to emotional intelligence. In all of them, the mixed ANOVA revealed simple effect of Time and significant interaction between Group and Time, with large effect sizes.

Since the interaction effect was significant, we performed repeated measures unifactor ANOVAs with Bonferroni post-hoc tests that show that there are differences after the intervention between the RTG and CG experimental groups in perception ($MD = 4.60$; $p = 0.023$), comprehension ($MD = 5.734$; $p = 0.005$) and regulation ($MD = 8.576$; $p < 0.000$). In turn, post-intervention differences were also observed between the NPG and CG experimental groups in perception ($MD = 4.156$; $p = 0.041$), comprehension ($MD = 4.473$; $p = 0.033$) and regulation ($MD = 6.511$; $p = 0.001$). Finally, no differences were observed between the RTG and NPG experimental groups after the intervention in perception ($MD = 0.444$; $p = 1.00$), comprehension ($MD = 1.261$; $p = 1.00$), and regulation ($MD = 2.065$; $p = 0.958$).

Figs. 2–4 show the differences in the three variables at the two time points tested.

3.3. Respiratory fatigue

Table 5 shows the results of the mixed ANOVAs performed on the two variables related to respiratory fatigue (FEV1 and FCV). In all of them, the mixed ANOVA revealed simple effect of Time and significant interaction between Group and Time, with large effect sizes.

Since the interaction effect was significant, we performed repeated measures unifactor ANOVAs with Bonferroni post-hoc tests. In the variable FEV1 differences were found during intervention between RTG and CG ($MD = 0.862$; p = 0.005); and post-intervention between RTG and CG ($MD = 1.437$; $p < 0.001$) and between NPG and CG ($MD = 0.887$; $p = 0.001$). Finally, in the FCV variable, post-

Table 3
Results of Mixed ANOVAs on the four variables of physiological stress.

	Time			Interaction Group and Time		
	F	MSE	p	F	MSE	p
HR	$F_{(1.558,134)} = 14.219$	7811.247	<0.000	$F_{(3.116,134)} = 2.560$	1406.232	0.057
rMSSD	$F_{(1.558,134)} = 14.219$	36681.118	0.004	$F_{(2.754,134)} = 2.646$	5796.883	0.058
HF	$F_{(1.252,134)} = 7.848$	472080832.180	0.004	$F_{(2.505,134)} = 0.545$	32794446.344	0.703
LF	$F_{(1.077,134)} = 7.848$	2865368716.870	0.018	$F_{(2.153,134)} = 0.704$	358798729.537	0.508

Note. HR = heart rate; rMSSD = mean root squared standard mean; HF = high frequency domain; LF = low frequency domain.

Table 4
Results of Mixed ANOVAs on the three variables of emotional intelligence.

	Time				Interaction Group and Time			
	F	MSE	p	η_p^2	F	MSE	p	η_p^2
Emotion Attention	$F_{(1,67)} = 8.042$	94.046	0.006	0.107	$F_{(2,67)} = 10.839$	126.747	<0.000	0.244
Emotion Clarity	$F_{(1,67)} = 9.306$	91.079	0.003	0.122	$F_{(2,67)} = 14.685$	143.719	<0.000	0.305
Emotion Repair	$F_{(1,67)} = 5.527$	87.861	0.022	0.076	$F_{(2,67)} = 6.748$	107.272	0.002	0.168

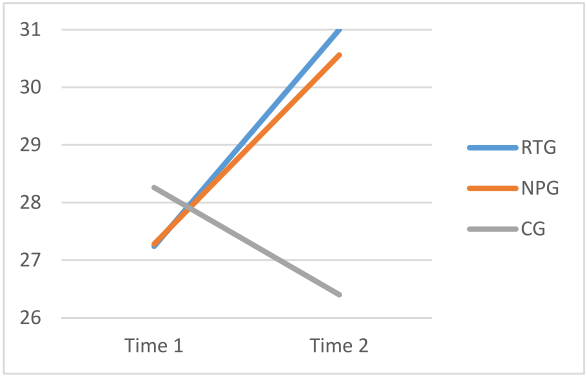

Fig. 2. Estimated marginal mean of emotional attention pre and post interventions. *Note*. RTG = Respiratory Training group; NPG = Nutritional Program Group; GC = Control Group.

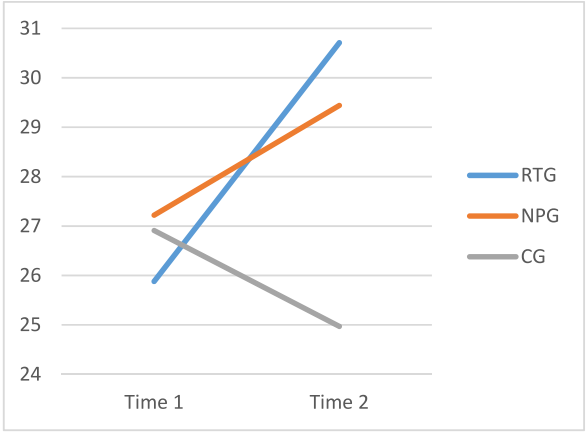

Fig. 3. Estimated marginal mean of emotional clarity pre and post interventions. *Note*. RTG = Respiratory Training group; NPG = Nutritional Program Group; GC = Control Group.

intervention differences were found between RTG and CG ($MD = 1.608$; $p < 0.001$) and between NPG and CG ($MD = 1.183$; $p < 0.001$).

Figs. 5 and 6 show the differences between the two variables at the three-time points tested.

4. Discussion

This study was designed to analyze the effects of a healthy Mediterranean diet and respiratory muscle training in higher artistic education specializing in oboe, clarinet, flute, and bassoon instruments. The results of this study suggest that the interventions had no significant effect on physiological stress indicators. However, the emotional intelligence values and respiratory fatigue scores improved, despite no significant differences between the two experimental groups.

From a dietary perspective, correct food intake implies correct and balanced caloric intake of macronutrients. Musicians must maintain intakes adapted to their individual needs, given the caloric demands of their performances and the continuous physical stress they have through musical performances or tours [14]. Therefore, the Mediterranean diet allows for the administration of various macro- and micronutrients necessary to meet their demands and to address cultural aspects, physical activity, eating habits, and even culinary methods [15]. Such dietary patterns have been widely referenced in scientific literature for their advantages in cardiovascular

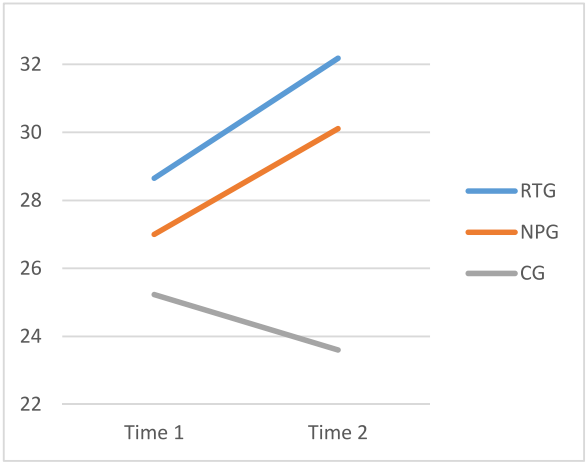

Fig. 4. Estimated marginal mean of emotional repair pre and post interventions. *Note*. RTG = Respiratory Training group; MPG = Nutritional Program Group; GC = Control Group.

Table 5
Results of Mixed ANOVAs on the two variables of respiratory fatigue.

	Time				Interaction Group and Time			
	F	MSE	p	η_p^2	F	MSE	p	η_p^2
FEV1	$F_{(2,134)} = 50.557$	30.196	<0.000	0.430	$F_{(4,67)} = 19.325$	11.542	<0.000	0.366
FCV	$F_{(2,67)} = 21.052$	12.965	<0.000	0.239	$F_{(4,67)} = 18.471$	11.375	<0.000	0.355

Note. FEV1 = forced expired volume; FCV = forced vital capacity.

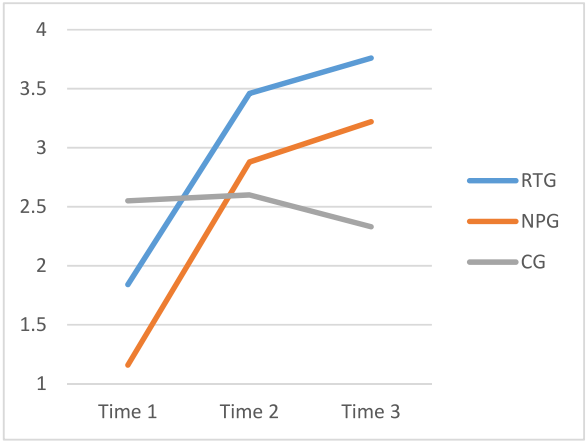

Fig. 5. Estimated marginal mean of FEV1 pre, during and post interventions. *Note*. RTG = Respiratory Training group; MPG = Nutritional Program Group; GC = Control Group.

health, metabolic well-being, and improved academic performance [16–19]. Therefore, the results obtained in this study could be explained by the benefits of following a Mediterranean diet. Health implies adopting a diet whose food base is based on fruits, vegetables, and legumes, thus improving the musician's well-being and performance on stage [17].

The absence of differences in HRV between respiratory exercise (RTG) or dietary work (NPG) groups indicates that further studies are needed, as well as a longer observation time of at least one academic year of the intervention groups with students to determine if there is indeed an improvement in the indicators of cardiovascular physiological stress [82,83].

Given that emotional intelligence and emotional management are powerful modulators, the results obtained from intervention with the Mediterranean diet, with or without respiratory training, are of great relevance in the development of musical performance. The improvement in these variables related to emotional intelligence (perception, understanding, and regulation) after the Mediterranean diet intervention suggests that musicians who carry out nutritional control and monitoring seem to have a greater capacity to

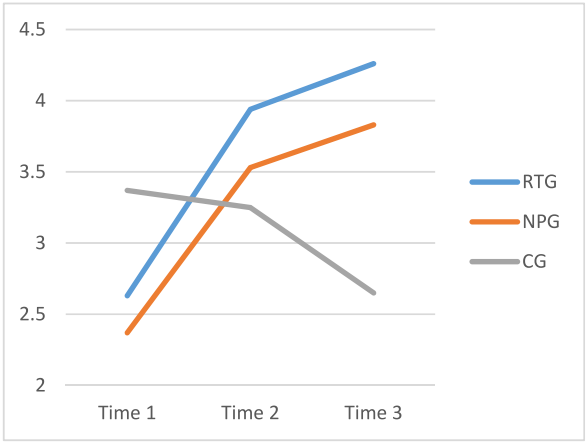

Fig. 6. Estimated marginal mean of FCV pre, during and post interventions. *Note*. RTG = Respiratory Training group; MPG = Nutritional Program Group; GC = Control Group.

regulate and be aware of emotions [84]. In this sense, the Mediterranean diet is one of the most beneficial nutritional pattern for students undergoing training, and has been observed to have a significant impact on emotional regulation [15,28]. Specifically, students who do not strictly follow this diet showed a negative correlation with the management of adverse emotions. Conversely, those who adhered closely to the Mediterranean diet demonstrate positive associations across various facets of emotional intelligence. However, in our study, we did not find significant differences between both experimental groups; therefore, it seems that respiratory muscle training did not modulate any dimension of emotional intelligence in the short term, making it possible to determine whether it would have been studied in the longer term or if another profile of brass instrumentalists who require greater ventilatory capacity would have been chosen [53,54].

The results of our study indicate that there were improvements in respiratory fatigue values in the two experimental groups compared to the control group, although there were no significant differences between them. This suggests that following a Mediterranean diet in the short term can have a positive effect on improving respiratory fatigue; however, a longer period of respiratory training is required to contribute to improving ventilatory capacity by exercising both the diaphragm and intercostal muscles, which are mainly responsible for pulmonary ventilation. Therefore, seeking a synergistic effect between nutrition and lung exercise is crucial to mitigate respiratory fatigue in student musicians [82].

Our study had several limitations. First, there is a lack of literature on the relationship between the Mediterranean diet, respiratory training, and musicians in academic training. As a result, we searched for more general scientific literature related to different sports specialties or other publications on trained professional musicians [56]. Another limitation was the intervention time, adapting to academic needs, as well as the difficulty of finding a sufficient sample for the data to be statistically significant, which is why instrumentalists from other modalities such as pedagogy, conducting, or composition were included as long as they played oboe, flute, clarinet, or bassoon in the four courses of higher artistic education or master's degree at the Higher Conservatory of Music of Valencia. Possibly due to all this, it was found that there were no differences between the experimental groups in the cardiovascular variables analyzed (HR, rMSSD, HF, LF), giving rise to insufficient intervention time and different hours of dedication to the instrument in each instrumentalist, and according to the training specialties.

Another aspect to be considered was the creation of personalized diets for each study subject, according to their dietary tastes or food preferences. This conditioned the type of diet to follow. Even though the food base was fruit, vegetables, and greens, four students followed vegan diet patterns (based on products that do not come from animal sources), lacto-ovo vegetarian (based on vegetables including dairy products and eggs), pescatarian (based on plants but incorporating fish and seafood with or without eggs and dairy), or vegetarian diet (excluding foods that come directly from animals without taking into account honey, dairy, and eggs), mainly for health reasons or ethical criteria due to their positive environmental impact [63]. This may have led to variations in emotional intelligence, respiratory fatigue, or the evolution of anthropometric variables when comparing these dietary patterns with the classic Mediterranean diet [28].

Finally, emotional intelligence was evaluated using the TMMS-24 questionnaire, which is not free of limitations because it subdivides emotional intelligence into emotional perception, understanding, and regulation [36]. Other evaluation methods are needed, such as the evaluation of emotional intelligence through co-assessment of social competence [84], and psychometric applications [83] to ensure that the statistically significant difference observed in emotional intelligence between the two experimental groups and the control is due to the dietary recommendations followed, as well as the daily respiratory training patterns.

It is essential to integrate topics on nutrition, self-care, and sports practice into the curriculum of higher musical education to fully develop the potential of instrumental performers. Moreover, further research on student parameters is necessary to generate additional bibliographic sources on the subject and to provide solid scientific evidence regarding the nutritional, physiotherapeutic, or sports advice that should be provided to professional musicians.

5. Conclusions

- Respiratory training improves musicians' emotional intelligence and reduces respiratory fatigue.
- The combination of respiratory training with the Mediterranean diet improves improved emotional comprehension, regulation, and perception.
- Limited impact on physiological stress was obtained: longer-term studies are needed.
- Recommendation: Musicians and conservatories should adopt both interventions to optimize performance by increasing parasympathetic tone.

Ethical statement

The study protocols and procedures were approved by the Ethics Committee of the Catholic University of Valencia "San Vicente Mártir", with project code UCV/2020–2021/084. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The study strictly adhered to the ethical guidelines for human experimentation.

Funding

This research did not receive any specific funding.

CRediT authorship contribution statement

Carlos Sanchis: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Conceptualization. **Marcos Plaza:** Resources, Project administration, Methodology, Investigation, Conceptualization. **Irene Checa:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Cristina Monleón:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: I.C. is an associate Editor of Heliyon Psychology journal. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Authors would like to all the conservatoires and superior music schools involved in the study.

References

[1] S. Carmel, Health and well-being in late life: gender differences worldwide, Front. Med. (6) (2019) 218, https://doi.org/10.3389/fmed.2019.00218.
[2] M.J. Gibney, C.G. Forde, Nutrition research challenges for processed food and health, Nat Food 3 (2) (2022) 104–109, https://doi.org/10.1038/s43016-021-00457-9.
[3] M.K. Taylor, D.K. Sullivan, E.F. Ellerbeck, B.J. Gajewski, H.D. Gibbs, Nutrition literacy predicts adherence to healthy/unhealthy diet patterns in adults with a nutrition-related chronic condition, Publ. Health Nutr. 22 (12) (2019) 2157–2169, https://doi.org/10.1017/S1368980019001289.
[4] C. Gallego, Effects on physical condition of an exercise programme in clarinettist and oboist vocational education students through an E-learning tool, Apunts (140) (2020), 86-86.
[5] É.F. Pereira, F. Kothe, FT. de S. Bleyer, C.S. Teixeira, Work-related stress and musculoskeletal complaints of orchestra musicians, Rev Dor 15 (2014) 112–116, https://doi.org/10.5935/1806-0013.20140025.
[6] J. Stanhope, R. Tooher, D. Pisaniello, P. Weinstein, Have musicians' musculoskeletal symptoms been thoroughly addressed? A systematic mapping review, Int. J. Occup. Med. Environ. Health 32 (3) (2019) 291–331, https://doi.org/10.13075/ijomeh.1896.01340.
[7] K.V. Shinde, P. Borkar, Epidemiology of musculoskeletal disorders in musicians - systematic review, Int. J. Health Sci. Res. 11 (12) (2021) 114–127, https://doi.org/10.52403/ijhsr.20211217.
[8] J. Vaag, I. Saksvik-Lehouillier, J.H. Bjørngaard, O. Bjerkeset, Sleep difficulties and insomnia symptoms in Norwegian musicians compared to the general population and workforce, Behav. Sleep Med. 14 (3) (2016) 325–342, https://doi.org/10.1080/15402002.2015.1007991.
[9] F.B. Kochem, J.G. Silva, Prevalence and associated factors of playing-related musculoskeletal disorders in Brazilian violin players, Med. Probl. Perform. Ar. 32 (1) (2017) 27–32, https://doi.org/10.21091/mppa.2017.1006.
[10] E. Altenmüller, in: J. Bogousslavsky, F. Boller (Eds.), Robert Schumann's Focal Dystonia. En, KARGER, Basel, 2005, pp. 179–188.
[11] R. Matei, S. Broad, J. Goldbart, J. Ginsborg, Health education for musicians, Front. Psychol. 9 (2018), https://doi.org/10.3389/fpsyg.2018.01137.
[12] D.T. Kenny, J. Cormack, R. Martin, Suffering for one's art: performance related musculoskeletal disorders in tertiary performing arts students in music and dance, in: Intern Symposium on Performance Science, 2009, pp. 25–30.
[13] C. Zaza, Prevention of musicians' playing-related health problems: rationale and recommendations for action, Med. Probl. Perform. Ar. 8 (4) (1993) 117–121.
[14] E. Cizek, P. Kelly, K. Kress, M. Mattfeldt-Beman, Factors affecting healthful eating among touring popular musicians and singers, Med. Probl. Perform. Ar. 31 (2) (2016) 63–68, https://doi.org/10.21091/mppa.2016.2013.
[15] M. Guasch-Ferré, W.C. Willett, The Mediterranean diet and health: a comprehensive overview, J. Intern. Med. 290 (3) (2021) 549–566, https://doi.org/10.1111/joim.13333.

[16] K.V. Gantenbein, C. Kanaka-Gantenbein, Mediterranean diet as an antioxidant: the impact on metabolic health and overall wellbeing, Nutrients 13 (6) (2021) 1951, https://doi.org/10.3390/nu13061951.

[17] S. Martín-Peláez, M. Fito, O. Castaner, Mediterranean diet effects on type 2 diabetes prevention, disease progression, and related mechanisms. A review, Nutrients 12 (8) (2020) 2236, https://doi.org/10.3390/nu12082236.

[18] F. Sofi, F. Cesari, R. Abbate, G.F. Gensini, A. Casini, Adherence to Mediterranean diet and health status: meta-analysis, BMJ 337 (2008) a1344, https://doi.org/10.1136/bmj.a1344.

[19] H.A. Young, D. Benton, Heart-rate variability: a biomarker to study the influence of nutrition on physiological and psychological health? Behav. Pharmacol. 29 (2 and 3) (2018) 140, https://doi.org/10.1097/FBP.0000000000000383.

[20] Y. Gepner, I. Shelef, O. Komy, N. Cohen, D. Schwarzfuchs, N. Bril, et al., The beneficial effects of Mediterranean diet over low-fat diet may be mediated by decreasing hepatic fat content, J. Hepatol. 71 (2) (2019) 379–388, https://doi.org/10.1016/j.jhep.2019.04.013.

[21] L. Di Renzo, G. Cinelli, M. Dri, P. Gualtieri, A. Attinà, C. Leggeri, et al., Mediterranean personalized diet combined with physical activity therapy for the prevention of cardiovascular diseases in Italian women, Nutrients 12 (11) (2020) 3456, https://doi.org/10.3390/nu12113456.

[22] M. Antonopoulou, M. Mantzorou, A. Serdari, K. Bonotis, G. Vasios, E. Pavlidou, et al., Evaluating Mediterranean diet adherence in university student populations: does this dietary pattern affect students' academic performance and mental health? Int. J. Health Plann. Manag. 35 (1) (2020) 5–21, https://doi.org/10.1002/hpm.2881.

[23] E. Melguizo-Ibáñez, G. Badicu, F.M. Clemente, A.F. Silva, J.L. Ubago-Jiménez, G. González-Valero, Impact of emotional intelligence on adherence to the Mediterranean diet in elementary education school students. A structural equation model, PeerJ 10 (2022) e13839, https://doi.org/10.7717/peerj.13839.

[24] E. Melguizo-Ibáñez, G. González-Valero, G. Badicu, A. Filipa-Silva, F.M. Clemente, H. Sarmento, et al., Mediterranean diet adherence, body mass index and emotional intelligence in primary education students—an explanatory model as a function of weekly physical activity, Children 9 (6) (2022) 872, https://doi.org/10.3390/children9060872.

[25] E. Melguizo-Ibáñez, V. Viciana-Garófano, F. Zurita-Ortega, J.L. Ubago-Jiménez, G. González-Valero, Physical activity level, mediterranean diet adherence, and emotional intelligence as a function of family functioning in elementary school students, Children 8 (1) (2021) 6, https://doi.org/10.3390/children8010006.

[26] E. Melguizo-Ibáñez, F. Zurita-Ortega, J.L. Ubago-Jiménez, G. González-Valero, R. Caracuel-Cáliz, P. Puertas-Molero, Inteligencia Emocional y adherencia a la dieta mediterránea. Un modelo de ecuaciones estructurales en adolescentes de educación primaria de la provincia de Granada, Rev Psicol Deporte J Sport Psychol 30 (4) (2021) 69–77.

[27] G.C. Rampersaud, M.A. Pereira, B.L. Girard, J. Adams, J.D. Metzl, Breakfast habits, nutritional status, body Weight, and academic performance in children and adolescents, J. Am. Diet Assoc. 105 (5) (2005) 743–760, https://doi.org/10.1016/j.jada.2005.02.007.

[28] B. Bizzozero-Peroni, J. Brazo-Sayavera, V. Martínez-Vizcaíno, R. Fernández-Rodríguez, J.F. López-Gil, V. Díaz-Goñi, et al., High adherence to the mediterranean diet is associated with higher physical fitness in adults: a systematic review and meta-analysis, Adv. Nutr. 13 (6) (2022) 2195–2206, https://doi.org/10.1093/advances/nmac104.

[29] G. Muscogiuri, L. Verde, C. Sulu, N. Katsiki, M. Hassapidou, E. Frias-Toral, et al., Mediterranean diet and obesity-related disorders: what is the evidence? Curr Obes Rep 11 (4) (2022) 287–304, https://doi.org/10.1007/s13679-022-00481-1.

[30] A. Strüven, C. Holzapfel, C. Stremmel, S. Brunner, Obesity, nutrition and heart rate variability, Int. J. Mol. Sci. 22 (8) (2021) 4215, https://doi.org/10.3390/ijms22084215.

[31] N. Singh, K.J. Moneghetti, J.W. Christle, D. Hadley, D. Plews, V. Froelicher, Heart rate variability: an old metric with new meaning in the era of using mHealth technologies for health and exercise training guidance, Part One: Physiology and Methods 7 (4) (2018) 247–255, https://doi.org/10.15420/aer.2018.30.2.

[32] R. Wells, T. Outhred, J.A.J. Heathers, D.S. Quintana, A.H. Kemp, Matter over mind: a randomised-controlled trial of single-session biofeedback training on performance anxiety and heart rate variability in musicians, PLoS One 7 (10) (2012) e46597, https://doi.org/10.1371/journal.pone.0046597.

[33] A. Williamon, L. Aufegger, D. Wasley, D. Looney, D.P. Mandic, Complexity of physiological responses decreases in high-stress musical performance, J. R. Soc., Interface 10 (89) (2013) 20130719, https://doi.org/10.1098/rsif.2013.0719.

[34] L. Sebastiani, F. Mastorci, M. Magrini, P. Paradisi, A. Pingitore, Synchronization between music dynamics and heart rhythm is modulated by the musician's emotional involvement: a single case study, Front. Psychol. 13 (2022) 908488, https://doi.org/10.3389/fpsyg.2022.908488.

[35] E. Sokoli, H. Hildebrandt, P. Gomez, Classical music students' pre-performance anxiety, catastrophizing, and bodily complaints vary by age, gender, and instrument and predict self-rated performance quality, Front. Psychol. 13 (2022), https://doi.org/10.3389/fpsyg.2022.905680.

[36] A.B. Górriz, E. Etchezahar, D.E. Pinilla-Rodríguez, M. del C. Giménez-Espert, A. Soto-Rubio, Validation of TMMS-24 in three Spanish-speaking countries: Argentina, Ecuador, and Spain, Int. J. Environ. Res. Publ. Health 18 (18) (2021) 9753, https://doi.org/10.3390/ijerph18189753.

[37] A. García-Dantas, J. González, F. González, Psychological factors related to intent to leave the musical teaching of performance professional, Cuad Psicol Deporte. enero de 14 (1) (2014) 39–44.

[38] M.M. Fernández, C.J. Brito, B. Miarka, A.L. Díaz-de-Durana, Anxiety and emotional intelligence: comparisons between combat sports, gender and levels using the trait meta-mood scale and the inventory of situations and anxiety response, Front. Psychol. 11 (2020), https://doi.org/10.3389/fpsyg.2020.00130.

[39] D. Sanz-Martín, F. Zurita-Ortega, P. Puertas-Molero, R. Caracuel-Cáliz, J.M. Alonso-Vargas, E. Melguizo-Ibáñez, Relationship between physical activity, mediterranean diet and emotional intelligence in Spanish primary education students, Children 10 (10) (2023) 1663, https://doi.org/10.3390/children10101663.

[40] E. Melguizo-Ibáñez, J.L. Ubago-Jiménez, G. González-Valero, G. Badicu, S.B. Al-Mhanna, P. Puertas-Molero, Study of the effects of physical-activity practice and adherence to the mediterranean diet on emotional intelligence in elementary school education students, Children 10 (7) (2023) 1211, https://doi.org/10.3390/children10071211.

[41] Ó. Gavín-Chocano, D. Molero, J.L. Ubago-Jiménez, I. García-Martínez, Emotions as predictors of life satisfaction among university students, Int. J. Environ. Res. Publ. Health 17 (24) (2020) 9462, https://doi.org/10.3390/ijerph17249462.

[42] E.J. Drinkwater, C.J. Klopper, Quantifying the physical demands of a musical performance and their effects on performance quality, Med. Probl. Perform. Ar. 25 (2) (2010) 66–71, https://doi.org/10.21091/mppa.2010.2013.

[43] L.S. Araújo, D. Wasley, R. Perkins, L. Atkins, E. Redding, J. Ginsborg, et al., Fit to perform: an investigation of higher education music students' perceptions, attitudes, and behaviors toward health, Front. Psychol. 8 (2017), https://doi.org/10.3389/fpsyg.2017.01558.

[44] B. Ackermann, R. Adams, E. Marshall, Strength or endurance training for undergraduate music majors at a university? Med. Probl. Perform. Ar. 17 (1) (2002) 33–41, https://doi.org/10.21091/mppa.2002.1006.

[45] S.H. Lee, S. Carey, R. Dubey, R. Matz, Intervention program in college instrumental musicians, with kinematics analysis of cello and flute playing: a combined program of yogic breathing and muscle strengthening-flexibility exercises, Med. Probl. Perform. Ar. 27 (2) (2012) 85–94, https://doi.org/10.21091/mppa.2012.2016.

[46] M. Roos, J.S. Roy, Effect of a rehabilitation program on performance-related musculoskeletal disorders in student and professional orchestral musicians: a randomized controlled trial, Clin. Rehabil. 32 (12) (2018) 1656–1665, https://doi.org/10.1177/0269215518785000.

[47] E. Bouros, V. Protogerou, O. Castana, G. Vasilopoulos, Respiratory function in wind instrument players, Mater. Soc. Med. 30 (2) (2018) 204, https://doi.org/10.5455/msm.2018.30.204-208.

[48] G. Macovei, R. Minea, I.T. Dumitraș, C.A. Precup, L. Baroiu, A. Nechifor, et al., Changes in dento-facial morphology induced by wind instruments, in professional musicians and physical exercises that can prevent or improve them—a systematic review, Life 13 (7) (2023) 1528, https://doi.org/10.3390/life13071528.

[49] R.J. Shei, Recent advancements in our understanding of the ergogenic effect of respiratory muscle training in healthy humans: a systematic review, J. Strength Condit Res. 32 (9) (2018) 2665–2676, https://doi.org/10.1519/jsc.0000000000002730.

[50] E. Harbour, T. Stöggl, H. Schwameder, T. Finkenzeller, Breath tools: a synthesis of evidence-based breathing strategies to enhance human running, Front. Physiol. 13 (2022), https://doi.org/10.3389/fphys.2022.813243.

[51] D. Fernández-Lázaro, L.A. Corchete, J.F. García, D. Jerves Donoso, E. Lantarón-Caeiro, R. Cobreros Mielgo, et al., Effects on respiratory pressures, spirometry biomarkers, and sports performance after inspiratory muscle training in a physically active population by Powerbreath®: a systematic review and meta-analysis, Biology. enero de 12 (1) (2023) 56.

[52] D. Fernández-Lázaro, D. Gallego-Gallego, L.A. Corchete, D. Fernández Zoppino, J.J. González-Bernal, B. García Gómez, et al., Inspiratory muscle training program using the PowerBreath®: does it have ergogenic potential for respiratory and/or athletic performance? A systematic review with meta-analysis, Int. J. Environ. Res. Publ. Health 18 (13) (2021) 6703, https://doi.org/10.3390/biology12010056.

[53] C. Yilmaz, S. Erail, Comparative analysis of the effects of sport and music on the respiratory system, Int J Disabil Sports Health Sci (2023) 178–184, https://doi.org/10.33438/ijdshs.1354035.

[54] C. Yilmaz, Ö. Bostancı, S. Bulut, Effect of respiratory muscle training on pitch range and sound duration in brass instrument players and singers, J. Voice 36 (1) (2022) 76–82, https://doi.org/10.1016/j.jvoice.2020.04.012.

[55] K. Dries, W. Vincken, J. Loeckx, D. Schuermans, J. Dirckx, Effects of a respiratory muscle training program on respiratory function and musical parameters in saxophone players, J. N. Music Res. 46 (4) (2017) 381–393, https://doi.org/10.1080/09298215.2017.1358751.

[56] R.E. Catalin, F. Martin-Lujan, P. Salamanca-Gonzalez, M. Palleja-Millan, F. Villalobos, A. Santigosa-Ayala, et al., Mediterranean diet and lung function in adults current smokers: a cross-sectional analysis in the MEDISTAR project, Nutrients 15 (5) (2023) 1272, https://doi.org/10.3390/nu15051272.

[57] Y.Y. Cheng, S.Y. Lin, C.Y. Hsu, P.K. Fu, Respiratory muscle training can improve cognition, lung function, and diaphragmatic thickness fraction in male and non-obese patients with chronic obstructive pulmonary disease: a prospective study, J. Personalized Med. 12 (3) (2022) 475, https://doi.org/10.3390/jpm12030475.

[58] E. Scoditti, M. Massaro, S. Garbarino, D.M. Toraldo, Role of diet in chronic obstructive pulmonary disease prevention and treatment, Nutrients 11 (6) (2019) 1357, https://doi.org/10.3390/nu11061357.

[59] J.A. Vitale, M. Bonato, A. La Torre, G. Banfi, Heart rate variability in sport performance: do time of day and chronotype play A role? J. Clin. Med. 8 (5) (2019) 723, https://doi.org/10.3390/jcm8050723.

[60] RM de Abreu, P. Rehder-Santos, V. Minatel, GL dos Santos, A.M. Catai, Effects of inspiratory muscle training on cardiovascular autonomic control: a systematic review, Auton Neurosci Basic Clin 208 (2017) 29–35, https://doi.org/10.1016/j.autneu.2017.09.002.

[61] E.M. Wanke, E.K. Kunath, F. Koch, J. Davenport, B. Weisser, D.A. Groneberg, et al., Survey of health problems in musical theater students: a pilot study, Med. Probl. Perform. Ar. 27 (4) (2012) 205–211, https://doi.org/10.21091/mppa.2012.4038.

[62] I. Marques-Lopes, S. Menal-Puey, J.A. Martínez, G. Russolillo, Development of a Spanish food exchange list: application of statistical criteria to a rationale procedure, J. Acad. Nutr. Diet. 118 (7) (2018) 1161–1169, https://doi.org/10.1016/j.jand.2017.04.010.

[63] G. Cubas de Basterrechea, C. González Antón, C. de la Vega-Hazas Pérez, I. Elío Pascual, P. Muñoz Cacho, [Adherence to the healthy eating guide issued by the Sociedad Española de Nutrición Comunitaria (SENC) (2018) among non-institutionalized elderly in Santander, Spain], Nutr. Hosp. 37 (5) (2020) 933–943, https://doi.org/10.20960/nh.03093.

[64] J. Aranceta Bartrina, Val V. Arija, E. Maíz Aldalur, E. Martínez de Victoria Muñoz, R.M. Ortega Anta, et al., Grupo Colaborativo de la Sociedad Española de Nutrición Comunitaria (SENC), [Dietary Guidelines for the Spanish population (SENC, diciembre 2016); the new graphic icon of healthy food], Nutr. Hosp. 33 (Suppl 8) (2016) 1–48, https://doi.org/10.20960/nh.82.

[65] A. Arias, G. Feijoo, M.T. Moreira, Exploring the potential of antioxidants from fruits and vegetables and strategies for their recovery, Innovat. Food Sci. Emerg. Technol. 77 (2022) 102974, https://doi.org/10.1016/j.ifset.2022.102974.

[66] S. de la Cruz Marcos, B. de Mateo Silleras, M.A. Camina Martín, L. Carreño Enciso, A. Miján de la Torre, J.E. Galgani Fuentes, et al., Proposal for a new formula for estimating resting energy expenditure for healthy Spanish population, Nutr. Hosp. 32 (5) (2015) 2346–2352, https://doi.org/10.3305/nh.2015.32.5.9680.

[67] A. Bosy-Westphal, W. Later, B. Hitze, T. Sato, E. Kossel, C.C. Glüer, et al., Accuracy of bioelectrical impedance consumer devices for measurement of body composition in comparison to whole body magnetic resonance imaging and dual X-ray absorptiometry, Obes. Facts 1 (6) (2008) 319–324, https://doi.org/10.1159/000176061.

[68] K.L. Vasold, A.C. Parks, D.M.L. Phelan, M.B. Pontifex, J.M. Pivarnik, Reliability and validity of commercially available low-cost bioelectrical impedance analysis, Int. J. Sport Nutr. Exerc. Metabol. 29 (4) (2019) 406–410, https://doi.org/10.1123/ijsnem.2018-0283.

[69] K. Acevedo, M. Guzmán, Efectos del entrenamiento respiratorio aislado en las variables respiratorias y vocales, Rev Investig E Innov En Cienc Salud 2 (2) (2020), https://doi.org/10.46634/riics.51.

[70] F.S. Souza, F.L.R.A.G. Leite, G.O. Ribeiro, T.A. Melo, B.G.M. Silva, E.E.T. França, Evaluation of respiratory musculature work in high performance athletes, Int J Sports Med Rehabil 1 (1) (2018), https://doi.org/10.28933/ijsmr-2018-05-0101.

[71] N. Mgbemena, A. Jones, A. Leicht, Assessment of inter-instrument reliability for dominant handgrip dynamometry and spirometry, Internet J. Allied Health Sci. Pract. 20 (4) (2022), https://doi.org/10.46743/1540-580X/2022.2147/8.

[72] N. Mgbemena, A. Jones, P. Saxena, N. Ang, S. Senthuran, A. Leicht, Recovery of lung function, dominant handgrip strength, and health-related quality of life in cardiac surgical patients following hospital discharge, Internet J. Allied Health Sci. Pract. 21 (2) (2023), https://doi.org/10.46743/1540-580X/2023.2304.

[73] W. Kamal, A. Osailan, G. Nambi, S. Moawd, A. Ahmed, A. Elshehawy, et al., Assessment of the different effects of passive smoking on lung volumes between athlete and non-athlete young adults, Case-Control Study 24 (103) (2020) 1461–1468.

[74] M. Waters, Perceptions of playing-related discomfort/pain among tertiary string students: a general overview of contributing factors, Int. J. Music Educ. 37 (2) (2019) 226–242, https://doi.org/10.1177/0255761419833078.

[75] C. Iñesta, N. Terrados, D. García, J.A. Pérez, Heart rate in professional musicians, J. Occup. Med. Toxicol. 3 (1) (2008) 16, https://doi.org/10.1186/1745-6673-3-16.

[76] P. Chhetri, L. Shrestha, N.B. Mahotra, Validity of elite-HRV smartphone application for measuring heart rate variability compared to polar V800 heart rate monitor, J Nepal Health Res Counc 19 (4) (2022) 809–813, https://doi.org/10.33314/jnhrc.v19i04.3949.

[77] A.E. Aubert, B. Seps, F. Beckers, Heart rate variability in athletes, Sports Med. 33 (12) (2003) 889–919, https://doi.org/10.2165/00007256-200333120-00003.

[78] A. Roldán, A. Cordellat, P. Monteagudo, C. García-Lucerga, N.M. Blasco-Lafarga, M.C. Gomez-Cabrera, et al., Beneficial effects of inspiratory muscle training combined with multicomponent training in elderly active women, Res. Q. Exerc. Sport 90 (4) (2019) 547–554, https://doi.org/10.1080/02701367.2019.1633009.

[79] P. Düking, C. Zinner, J.L. Reed, H.C. Holmberg, B. Sperlich, Predefined vs data-guided training prescription based on autonomic nervous system variation: a systematic review, Scand. J. Med. Sci. Sports 30 (12) (2020) 2291–2304, https://doi.org/10.1111/sms.13802.

[80] N. Singh, K.J. Moneghetti, J.W. Christle, D. Hadley, V. Froelicher, D. Plews, Heart rate variability: an old metric with new meaning in the era of using mHealth technologies for health and exercise training guidance. Part Two: prognosis and training, Arrhythmia Electrophysiol. Rev. 7 (4) (2018) 247–255, https://doi.org/10.15420/aer.2018.27.2.

[81] F. Shaffer, J.P. Ginsberg, An overview of heart rate variability metrics and norms, Front. Public Health 5 (2017), https://doi.org/10.3389/fpubh.2017.00258.

[82] J. Konieczna, M. Ruiz-Canela, A.M. Galmes-Panades, I. Abete, N. Babio, M. Fiol, et al., An energy-reduced mediterranean diet, physical activity, and body composition: an interim subgroup analysis of the PREDIMED-plus randomized clinical trial, JAMA Netw. Open 6 (10) (2023) e2337994, https://doi.org/10.1001/jamanetworkopen.2023.37994.

[83] P.J. Marcos-Pardo, N. González-Gálvez, A. Espeso-García, T. Abelleira-Lamela, A. López-Vivancos, R. Vaquero-Cristóbal, Association among adherence to the mediterranean diet, cardiorespiratory fitness, cardiovascular, obesity, and anthropometric variables of overweight and obese middle-aged and older adults, Nutrients 12 (9) (2020) 2750, https://doi.org/10.3390/nu12092750.

[84] X. Wang, Y. Cai, D. Tu, The application of item response theory in developing and validating a shortened version of the Rotterdam Emotional Intelligence Scale, Curr. Psychol. 42 (26) (2023) 22949–22964, https://doi.org/10.1007/s12144-022-03329-y.