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Short Communication

Biomedical Human Kinetics, 15, 225–228, 2023
DOI: 10.2478/bhk-2023-0026

POWERbreathe® S-Index Test – guidelines and recommendations for practitioners

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Abstract

Study aim: POWERbreathe® S-Index Test is an accessible and functional evaluation of inspiratory muscle strength. The main purpose of this study is to present guidelines that allow to successfully apply the test in sports settings with high accuracy, robustness, and repeatability.

Material and methods: Review of available literature and professional guidelines regarding traditional spirometry testing and POWERbreathe® trainers' application was performed. The obtained information was summarized, analyzed, and interpreted to create POWERbreathe® S-Index Test guidelines and recommendations for practitioners. POWERbreathe® K4 and K5 (POWERbreathe International Ltd., Southam, UK) devices paired with Breathe-Link Live Feedback Software (POWERbreathe International Ltd., Southam, UK) were considered during the analysis and guidelines creation.

Results: We recommend performing POWERbreathe® S-Index Test with 8 forceful and dynamic inspiratory maneuvers from residual volume to full inspiratory capacity, divided into 2–3 series of 2–3 maneuvers, in a standing position, after respiratory warm-up.

Conclusion: POWERbreathe® S-Index Test may be a useful tool to measure functional inspiratory muscle strength in athletes. When performed with the presented guidelines, it can be successfully applied in sports settings with high accuracy, robustness, and repeatability.

Keywords: Respiratory muscle training – Pulmonary function – Powerbreathe – S-index – Spirometry

Introduction

In the last few decades, a significant amount of evidence indicating the importance of inspiratory strength and fatigue resistance in athletic performance has emerged. Systematic literature reviews have found that respiratory muscle training (RMT) can improve endurance performance and pulmonary function [3, 4].

In order to tailor the training program to their individual needs and abilities, it is recommended to evaluate an athlete's inspiratory muscle strength and endurance, as well as their pulmonary function, prior to considering the introduction of RMT protocol. Maximal Inspiratory Pressure (MIP) is a widely used traditional spirometry measure of inspiratory muscle strength. However, in many countries, spirometry testing is considered a medical examination and is subject to specific regulations that restrict it to specialized medical professionals only. Moreover, MIP is based on static effort and may be considered an isometric measure. Therefore, to evaluate the maximum inspiratory pressure in a sports settings we recommend S-Index Test, which is a recently introduced tool developed by POWERbreathe® (POWERbreathe International Ltd., Southam, UK). S-Index Test is based on maximum, forceful inspirations performed from residual volume to full inspiratory capacity. Since S-Index Test uses dynamic maneuvers, therefore we speculate that it may be a more specific and functional assessment in athletes than traditional static spirometry measures. Moreover, it can be performed with mobile, handheld devices, and to our knowledge there are no formal restrictions regarding practitioners' qualifications. S-Index Test performed with POWERbreathe® devices has been appropriately validated [1, 5, 7]. Test-to-test and day-to-day reliability has been found excellent [7] and it allows to evaluate the inspiratory strength in both healthy individuals and patients [1, 5].

The traditional spirometry examination follows established guidelines developed by expert groups, enabling consistent and comparable results. While POWERbreathe®

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offers basic instructions on how to conduct an S-Index Test, there are currently no comprehensive and detailed guidelines that address the testing methodology. Therefore, based on available literature and vast practical experience we propose the following approach to performing S-Index Tests. The rationale behind described choices is provided.

Equipment and conditions

Many POWERbreathe® devices are equipped with testing options, however as of today only POWERbreathe® K4 and POWERbreathe® K5 devices allow to perform S-Index Test with Breathe-Link Live Feedback Software. The software allows to perform multiple breathing maneuvers in one session and observe breathing characteristics in real-time on a computer or tablet screen, due to the 500 Hz frequency of pressure and flow processing. Therefore we recommend POWERbreathe® K-series devices with paired software, connected to a computer or tablet screen as standard test setting. The subject should be able to see the screen and observe ongoing breathing performance during warm-up and proper test, which allows to adjustment of breathing characteristics to maximize the test result. A default load of 3 cmH_2O, preset by the manufacturer, should be used. S-Index is measured with ±3% accuracy and displayed in 0–240 cmH_2O range.

Both high and low temperatures are associated with decrements in pulmonary function [2, 6], therefore we recommend performing S-Index Test in moderate ambient conditions (10–25 °C, 30–60% humidity) to compare with reference values. However, if S-Index Test is performed in the field, we emphasize the need for repeatable conditions to compare athletes' previous and current results. POWERbreathe® K-series devices operate accurately in temperatures from 5 to 40°C.

Detailed procedure

The first stage of the procedure is to present a general description of S-Index Test to the subject. At this stage, there is no need to provide a detailed explanation. The subject should be clearly informed about precautions and contraindications before beginning the respiratory muscles warm-up.

Respiratory muscles warm-up may enhance pulmonary function [8] and attenuate the 'learning effect' of repeated measurements [10]. Consequently, to accurately determine the maximum S-Index values, it is recommended to include the warm-up. We suggest allowing the subject to perform 10 easy to moderate voluntary breaths with the testing device for both warming-up and familiarising with the evaluation setting.

During repeated, forced, high-intensity respiratory maneuvers some subjects may feel a slight headache or

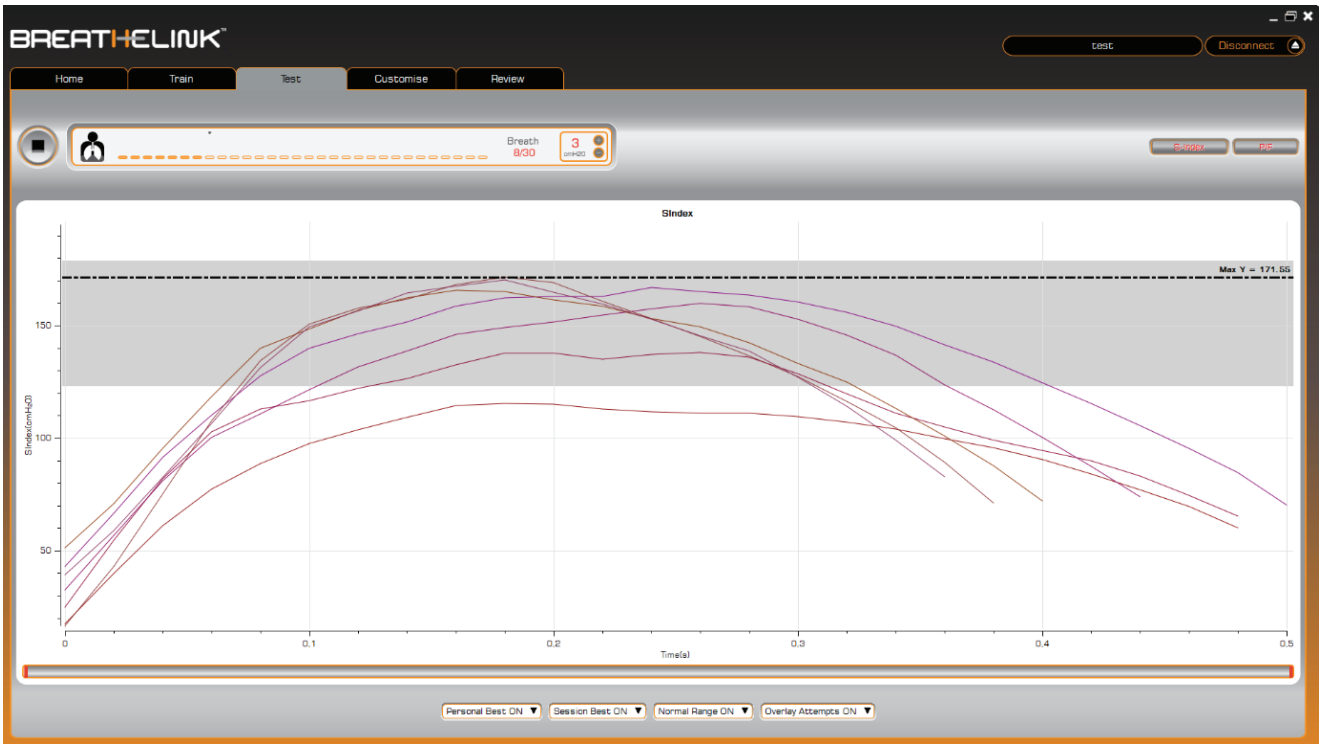


Figure 1. Real-time visualization of breathing characteristics provided by Breathe-Link Live Feedback Software, version 1.10f, during S-Index Test

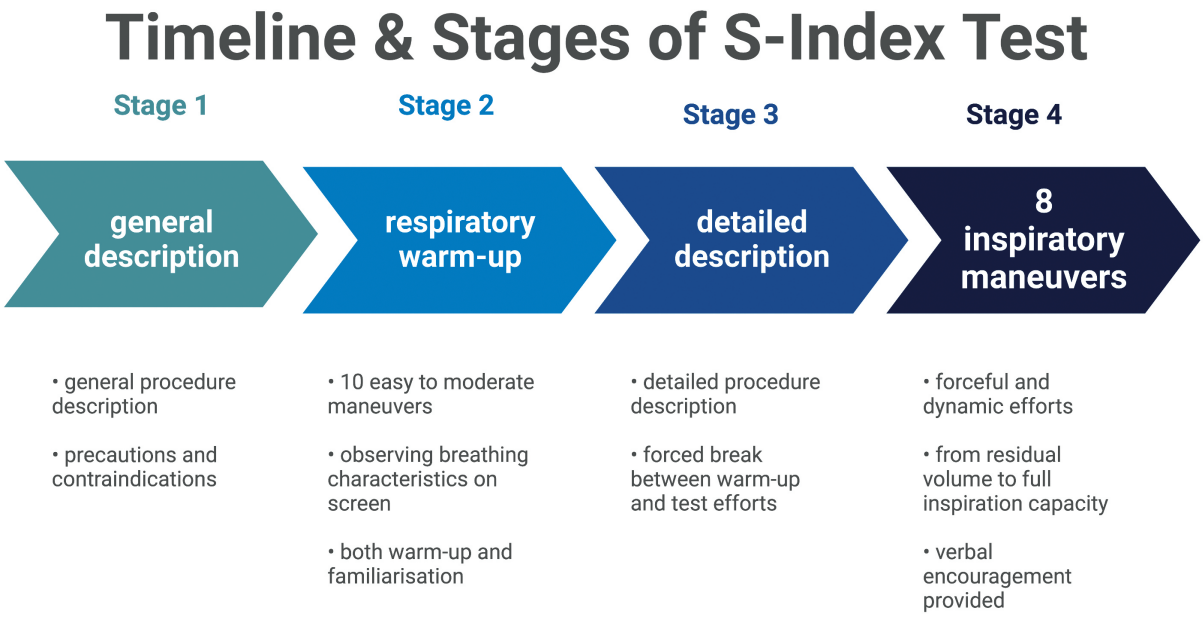


Figure 2. Timeline and Stages of S-Index Test. Adapted from Biorender Template, by BioRender.com (2023). Retrieved from https://app.biorender.com/biorender-templates

dizziness, associated with acute changes in blood's pH balance, as well as carbon dioxide and oxygen levels. Therefore, to avoid aggregating numerous maneuvers we suggest taking a 2–3 minute break between respiratory warm-up and the S-Index Test. A detailed explanation of the test should be provided during this time.

According to the literature, achieving the highest and most dependable S-Index results requires a minimum of 8 inspiratory maneuvers [9]. We recommend performing the test with a total of 8 maneuvers, divided into 2–3 series of 2–3 inspiratory maneuvers. All the maneuvers should be performed forcefully and dynamically, from residual volume to full inspiratory capacity. Verbal encouragement should be provided by the practitioner. The encouragement should address exhalation to achieve the residual volume before starting the inspiratory maneuver, and the inspiratory maneuver itself. Exemplary commends might include phrases such as "exhale", "breath out" or "out" for the exhalation and "inhale", "go" or "come on" for the inspiratory maneuver. The single highest cmH_2O value obtained during 8 maneuvers is the S-Index Test result.

We recommend performing S-Index Testing in a neutral standing position, which helps in providing repeatable conditions in different locations. Body weight should be evenly distributed on both limbs. Upper-body movements associated with natural breathing mechanics are allowed. A nose clip should be used, to eliminate any airflow not going through the testing device. In matters not described above, the manufacturer's recommendations should be followed.

Conclusions

POWERbreathe® S-Index Test may be a useful tool to measure functional inspiratory muscle strength in athletes. When performed with the aforementioned guidelines, it can be successfully applied in sports settings with high accuracy, robustness, and repeatability.

Conflict of interest: Authors state no conflict of interest.

References

1. Areias G.S., Santiago L.R., Teixeira D.S., Reis M.S. (2020) Concurrent Validity of the Static and Dynamic Measures of Inspiratory Muscle Strength: Comparison between Maximal Inspiratory Pressure and S-Index. *Braz J. Cardiovasc. Surg.*, 35(4): 459–464. DOI: 10.21470/1678-9741-2019-0269
2. Collaco J.M., Lawrence A.J, McGready J., Cutting G.R. (2018) The Relationship of Lung Function with Ambient Temperature. *PloS One*, 13(1): e0191409. DOI: 10.1371/journal.pone.0191409
3. HajGhanbari B., Yamabayashi C., Buna T.R., Coelho J.D, Freedman K.D., Morton T.A., Palmer S.A., Toy M.A., Walsh C., Sheel W.A., Reid D.W. (2013) Effects of Respiratory Muscle Training on Performance in Athletes: A Systematic Review with Meta-Analyses. *J.* Strength Cond. Res., 27(6): 1643–1663. DOI: 10.1519/JSC.0b013e318269f73f

4. Illi S.K., Held U., Frank I., Spengler C.M. (2012) Effect of Respiratory Muscle Training on Exercise Performance in Healthy Individuals: A Systematic Review and Meta-Analysis. *Sports Med*., 42(8): 707–724. DOI: 10.1007/BF03262290
5. Langer D., Jacome C., Charususin N., Scheers H., McConnell A.K., Decramer M., Gosselink R. (2013) Measurement Validity of an Electronic Inspiratory Loading Device during a Loaded Breathing Task in Patients with COPD. *Respir. Med.,* 107(4): 633–635. DOI: 10.1016/j.rmed.2013.01.020
6. Lin Z., Gu Y., Liu C., Song Y., Bai C., Chen R., Chen S., Kan H. (2018) Effects of Ambient Temperature on Lung Function in Patients with Chronic Obstructive Pulmonary Disease: A Time-Series Panel Study. *Sci. Total Environ.,* 619–620 (April): 360–365. DOI: 10.1016/j.scitotenv.2017.11.035
7. Minahan C., Sheehan B., Doutreband R., Kirkwood T., Reeves D., Cross T. (2015) Repeated-Sprint Cycling Does Not Induce Respiratory Muscle Fatigue in Active Adults: Measurements from the Powerbreathe® Inspiratory Muscle Trainer. *J. Sports Sci. Med.*, 14(1): 233–238.
8. Özdal M. (2016) Acute Effects of Inspiratory Muscle Warm-up on Pulmonary Function in Healthy Subjects. *Respir. Physiol. Neurobiol.*, 227(June): 23–26. DOI: 10.1016/j.resp.2016.02.006
9. Silva P.E., de Carvalho K.L., Frazão M., Maldaner V., Daniel C.R, Gomes-Neto N. (2018) Assessment of Maximum Dynamic Inspiratory Pressure. *Respir. Care*, 63(10): 1231–1238. DOI: 10.4187/respcare.06058
10. Volianitis S., McConnell A.K., Jones D.A. (2001) Assessment of Maximum Inspiratory Pressure. *Respiration,* 68(1): 22–27. DOI: 10.1159/000050458

Received 10.05.2023
Accepted 01.08.2023

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