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The effects of inspiratory muscle strengthening on MIP and quality of life of elderly nursing home patients.*

Los efectos del beneficio de la fuerza del músculo inspiratorio en la PIM y la calidad de vida de los pacientes mayores de la clínica de reposo.*

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Abstract

The objective of this study was to compare the effects of inspiratory muscle strengthening on maximal inspiratory pressure (MIP) and on quality of life among elderly nursing home patients. The study population was divided in two groups: experimental group- EG (n=21, 76.48 2.12 years) and control group- CG (n=13, 75.69 2.26 years). The World Health Organization Quality of Life Group (WHOQOL-100) questionnaire was used to evaluate the quality of life of the subjects. A Manovacuometer (analogical, with an operational interval of −150 to +150 cmH2O; Critical Med/USA-2002) was used to evaluate MIP. The study protocol consisted of a gradual increase in workload (50%-100%); the sessions lasted 20 minutes and were composed of 7 series of strengthening (2 minutes each) with a 1-minute interval between the series, 3 times a week for 10 weeks. Variance analysis of multivariate repeated measurements demonstrated significant differences only for MIP between CG (32,69±17,03 cmH2O versus 23,08±10,71 cmH2O) and EG (31,67±11,11 cmH2O versus 55,24±23,26 cmH2O), and the latter was higher than the former (p= 0,00000). Therefore, we concluded that inspiratory muscle strengthening led to an increase in MIP that did not improve quality of life. However, further studies should be done in this population to validate a quality of life questionnaire specific for the elderly.

Resumen

El objetivo de este estudio era comparar los efectos del músculo inspiratorio que consolidaban en la presión inspiratoria máxima (PIM) y en la calidad de la vida entre pacientes mayores de la clínica de reposo. Dividieron a la población del estudio en dos grupos: grupo experimental EG. (n=21,76.48 2.12 años) y grupo de control CG (n=13, 75.69 2.26 años). La calidad de la Organización Mundial de la Salud del cuestionario del grupo de la vida (WHOQOL-100) fue utilizada para evaluar la calidad de la vida de los temas. Un Manovacuometer (analógico, con un intervalo operacional - de 150 a +150 cmH2O; Med/USA-2002 crítico) fue utilizado para evaluar la MIP. El protocolo del estudio consistió en un aumento gradual en la carga de trabajo (50%-100%); las sesiones duraron 20 minutos y fueron compuestas de 7 series de consolidación (2 minutos cada uno) con un 1 intervalo minucioso entre la serie, 3 veces a la semana por 10 semanas. El análisis de variación de medidas repetidas multivariate demostró diferencias significativas solamente para la MIPS entre CG (32,69±17,03 cmH2O contra 23,08±10,71 cmH2O) y EG. (31,67±11,11 cmH2O contra 55,24±23,26 cmH2O), y el último era más alto que el anterior (p= 0.00000). Por lo tanto, concluimos que el músculo inspiratorio que consolidaba condujo a un aumento en la MIPS que no mejoró la calidad de la vida. Sin embargo, otros estudios se deben hacer en esta población para validar una calidad del específico del cuestionario de la vida para los ancianos.

Key words:nursing home patients; MIP; quality of life.

Palabras clave: pacientes de la clínica de reposo; PIM; calidad de la vida.

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Introduction

Elderly people who do not earn a good income present several severe complex physical, social, and psychological problems, which is the reason why they are eventually transferred to nursing homes. Life in philanthropic institutions, associated with other internal and external factors, decreases the quality of life of this population even further (Gerritsen et al., 2004).

Assuming that aging is the sum of every biological, psychological, and social change affecting an individual throughout a lifetime, several damaging factors can hinder the optimal levels of quality of life in this population (Guimarães et al., 2004).

According to the World Health Organization- WHO (OMS, 1998), quality of life is an option to be sought by each individual, being defined according to one's needs, hopes, and possibilities, being subjected to constant changes. It can also be defined as the individual's perception of his/her stand in life, in the context of the culture and value system in which he/she lives, and which is related to his/her objectives, expectations, patterns, and concerns.

One of the main factors concerning the decrease in quality of life is the dyspnea that the elderly complain about while performing activities of the daily life (ADL) (Pine et al., 2005). Dyspnea is related to a decrease in pulmonary function and in inspiratory muscular strength (Ide et al., 2005). This strength is represented by the Maximal Inspiratory Pressure – MIP (Green et al., 2002). A decrease in MIP can lead to exercise intolerance, which will lead to social isolation, anxiety, and depression (Steiner and Morgan, 2001).

The correlation between MIP and dyspnea and, consequently, with quality of life has been studied by many scholars in several areas, such as: cystic fibrosis (Enright et al., 2004), chronic obstructive pulmonary disease (COPD) (Covey et al., 2001), congestive heart failure (CHF) (Laoutaris et al., 2004), asthma (Weiner et al., 2002), spinal cord injuries (Liaw et al., 2000), tetraplegia (Uijl et al., 1999), ankylosing spondylitis (Van-Der-Esch et al., 2004), osteoporosis (Cimen et al., 2003), myasthenia gravis (Fregonezi et al., 2005), and multiple sclerosis (Klefbeck and Hamrah-Nedjad, 2003). However, there are very few studies on the influence of decreased MIP in seemingly healthy elderly individuals, especially in those who are sedentary.

Thus, the objective of this study was to evaluate the effects of inspiratory muscle strengthening on MIP and quality of life in elderly individuals in nursing homes.

Material and methods

Study Population

For this non-probabilistic study, the selection of the study group followed the criteria of convenience. The cohort was composed of 50 elderly volunteers, living in nursing homes in Jacarepagua borough, in Rio de Janeiro, Brazil. They were divided in two groups: experimental group (EG, n=25) and control group (CG, n=25). However, 14 subjects were excluded during the study. Therefore, the final study population was composed of: EG (n=21, 7 men and 14 women, 76.48±2.12 years) and CG (n=13, 3 men and 10 women, 75.69±2.26 years).

To be included in this study, individuals had to be physically capable of participating in the experimental treatment and to answer the quality of life questionnaire. They were also expected not have taken part in physical activities for at least three months (Kraemer et al., 2002).

Exclusion criteria included any acute or chronic condition that could hinder or could become a hindering factor for the intervention, such as: cardiopathies, diabetes, hypertension, and uncontrollable asthma; neurological problems; morbid obesity; chronic renal failure; and use of medication that could affect one's attention.

Patients signed an informed consent and the procedures were performed according to the ethical standards provided for by the 1964 Helsinki Declaration. The study was approved by the Ethics Committee on Human Research of the Universidade Castelo Branco, Rio de Janeiro, Brazil.

Procedures

Quality of life and MIP were evaluated before and after the test.

Evaluation of Quality of Life: The World Health Organization Quality of life Group – WHOQOL-100 (Fleck et al., 2003) questionnaire was used to evaluate quality of life of the study subjects. It is composed of one hundred questions that evaluate six domains: physical (DOM1), psychological (DOM2), level of independence (DOM3), social relationships (DOM4), environment (DOM5), and spiritual/religious/personal beliefs (DOM6). The questions were evaluated in each domain separately and in the overall quality of life, with a sufficiency score of 14.

Evaluation of maximal inspiratory pressure: Maximal inspiratory pressure (MIP) was evaluated using a Manovacuometer (analogical with an operational interval of –150 to +150 cmH_2O; Critical Med/USA-2001). It was used with a mouthpiece and the individual's nose was clamped. The residual volume was the starting point for MIP's measurement. The circuit has an opening that was occluded at the beginning of the inspiration to generate a negative intrathoracic pressure, which was confirmed by the manometer (Green et al., 2002). Inspiration lasted at least 3 seconds, being performed with the maximal effort and for as long as possible. The procedure was repeated three times, and only the best result was used (Volianitis et al., 2003). The pressure obtained represented the sum of the inspiratory muscles, since there is no way of measuring only the diaphragmatic effort.

Intervention protocol: The experimental group was submitted to a protocol aiming at strengthening the inspiratory muscles. The Threshold-IMT (Respironics/USA- 2004) was used to this end, using a linear pressure load that produces a resistance to inspiration through a system of coils. It has a unidirectional valve that opens during expiration and closes during inspiration. It is necessary to use a nasal clamp. Resistance increases with the degree of compression of the coil. The study subject was instructed to allow for a 4-second interval between respiratory efforts and to maintain the inspiration for at least 2 seconds (Mancini et al., 1999).

Although there are several protocols in the literature, we used a gradual increase of the workload, starting at 50% of MIP and increasing 10% every week until the 4^{th} week (Enright et al., 2004; Laoutaris et al., 20004). From the 5^{th} week on, we increased the workload by 5% until we reached 100% in the 8^{th} week. This level was maintained during the last 2 weeks. The sessions, lasting 20 minutes, consisted of 7 series of strengthening (2 minutes each) with a 1-minute interval between series (Sturdy et al., 2002), 3 times a week for 10 weeks (Klefbeck and Hamrah-Nedjad , 2003).

Subjects in the control group maintained their daily activities during the study. They did not perform any regular physical activity that involved muscular strengthening until the post-test evaluation.

Statistical Analysis

The Shapiro-Wilk test was used to evaluate the normalcy of the study group. Variance analysis of multivariate repetitive measurements was used to evaluate the differences among MIP, QOL, DOM1, DOM2, DOM3, DOM4, DOM5, and DOM6 due to the strengthening of the inspiratory muscles. A $p < 0.05$ was considered significant (Thomas and Nelson, 2002).

Results

Table 1 shows the descriptive analysis of the EG.

Table 1: Descriptive statistics of EG

	M		SE		M		SD		VC%		p (SW)
	Pre	Post	Pre	post	pre	post	pre	post	pre	post	
Age	76.48	76.48	2.12	2.12	74.00	74.00	9.71	9.71	12.70	12.70	0.202
BMI	25.99	26.02	1.13	1.14	25.95	25.95	5.17	5.22	19.89	20.05	0.578
MIP	31.67	55.24	2.42	5.08	35.00	55.00	11.11	23.26	35.07	42.11	0.180
QOL	14.43	14.62	0.78	0.66	15.00	15.00	3.56	3.02	24.66	20.69	0.652
DOM1	12.49	11.95	0.31	0.27	12.00	12.00	1.43	1.22	11.44	10.21	0.212
DOM2	13.65	13.71	0.51	0.45	14.40	13.80	2.35	2.07	17.21	15.06	0.101
DOM3	12.77	12.87	0.36	0.43	13.00	12.50	1.65	1.96	12.91	15.27	0.358
DOM4	13.10	12.84	0.51	0.42	13.00	13.00	2.36	1.92	17.99	14.96	0.32
DOM5	12.54	12.97	0.45	0.51	12.50	12.88	2.07	2.33	16.51	17.96	0.941
DOM6	16.14	16.10	0.74	0.73	17.00	16.00	3.38	3.35	20.94	20.78	0.045

M: means; SE: standard error; M: median; SD: standard deviation; VC: variation coefficient; SW: Shapiro-Wilk; BMI: body mass indice; MIP: maximal inspiratory pressure; QOL: quality of life; DOM1: physical; DOM2: psychological; DOM3: level of independence; DOM4: social relationships; DOM5: environment; DOM6: spiritual/religious/personal beliefs.

Table 2 shows the descriptive analysis of the CG.

Table 2: Descriptive statistics of CG

	M		SE		M		SD		VC%		p (SW)
	pre	post	pre	post	pre	post	pre	post	pre	post	
Age	75.69	75.69	2.26	2.26	77.00	77.00	8.14	8.14	10.75	10.75	0.860
BMI	25.80	26.01	0.79	0.69	26.27	26.14	2.85	2.50	11.05	9.62	0.757
MIP	32.69	23.08	4.72	2.97	30.00	20.00	17.03	10.71	52.10	46.42	0.336
QOL	14.69	14.85	0.98	1.11	14.00	16.00	3.54	4.00	24.13	26.92	0.693
DOM1	12.72	12.23	0.47	0.41	13.00	12.00	1.68	1.49	13.23	12.21	0.715
DOM2	13.68	13.18	0.54	0.69	13.60	13.40	1.96	2.47	14.33	18.77	0.250
DOM3	12.77	12.54	0.52	0.71	13.25	13.25	1.87	2.57	14.66	20.51	0.458
DOM4	13.18	12.92	0.61	0.60	13.67	12.33	2.21	2.16	16.79	16.73	0.443
DOM5	13.02	13.16	0.47	0.84	13.00	13.25	1.68	3.04	12.91	23.08	0.071
DOM6	15.77	15.77	0.88	0.88	16.00	16.00	3.17	3.17	20.08	20.08	0.140

*M: means; SE: standard error; M: median; SD: standard deviation; VC: variation coefficient; SW: Shapiro-Wilk; BMI: body mass indice; MIP: maximal inspiratory pressure; QOL: quality of life; DOM1: physical; DOM2: psychological; DOM3: level of independence; DOM4: social relationships; DOM5: environment; DOM6: spiritual/religious/personal beliefs.

It can be observed, through table 1 and 2, that it had homogeniedade of the sample with exception of the DOM6 (EG). In the questionnaire WHOQOL-100, both the groups had gotten a level of considered quality of life unsatisfactory (OMS, 1998), with exception of the DOM6 and the QVG. Segundo Neder et al. (1999), the MIP reflected a low value of inspiratory muscular force in the CG (pre-test and post-test) and in EG (pre-test).

The test post hoc of Tukey, in relation to the inspiratory muscular force, detected that: (a) the initial values of MIP of the groups had been sufficiently similar (p=0,999); (b) in EG, the value of the MIP increased significantly (p=0,000) in relation to the initial values; (c) in the CG, the value of the MIP did not increase significantly (p=0,999)) in relation to the initial values; (d) the value of the MIP of that they had made the inspiratory strengthening muscular had been significantly bigger of what those that had not made (p=0,003), (Figure 1).

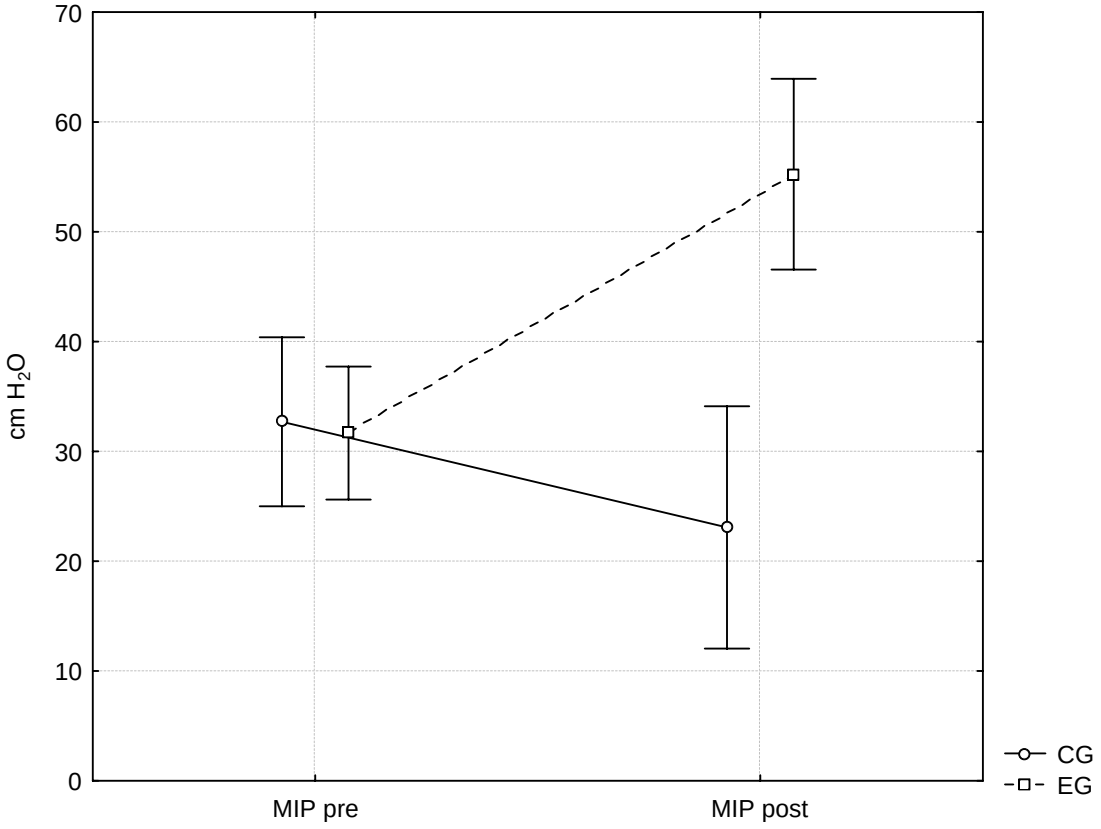

Figure 1: Interaction of the inspiratory muscular strengthening with the MIP.

$F(1 , 32) = 42,05 , p = 0,00000$

In relation to questionnaire WHOQOL-100, the test post hoc of Tukey detected that: (a) the values of QVG (p=0,99) and the diverse domains of the quality of life with muscular strengthening (DOM1: p=0,98; DOM2: p=0,99; DOM3: p=1,00; DOM4: p=0,99; DOM5: p=0,98 and DOM6: p=0,99) had been sufficiently similar; (b) in EG, did not have significant difference, in relation to the initial values, in: QVG (p=0,98), DOM1 (p=0,27), DOM2 (p=0,99), DOM3 (p=0,99), DOM4 (p=0,88), DOM5 (p=0,66), DOM6 (p=0,99); (c) in the CG, did not have significant difference, in relation to the initial values, in: QVG (p=0,99), DOM1 (p=0,57), DOM2 (p=0,69), DOM3 (p=0,99), DOM4 (p=0,94), DOM5 (p=0,99), DOM6 (p=0,99); (d) the values of QVG (p=0,99), DOM1 (p=0,97), DOM2 (p=0,97), DOM3 (p=0,99), DOM4 (p=0,99), DOM5 (p=0,99), DOM6 (p=0,99) of that had made the inspiratory muscular strengthening had not been significantly better of what those that they had not made (Figure 2) initial value; (d) the value of the MIP of that they had made the inspiratory strengthening muscular had been significantly bigger of what those that had not made (p=0,003), (Figure 2).

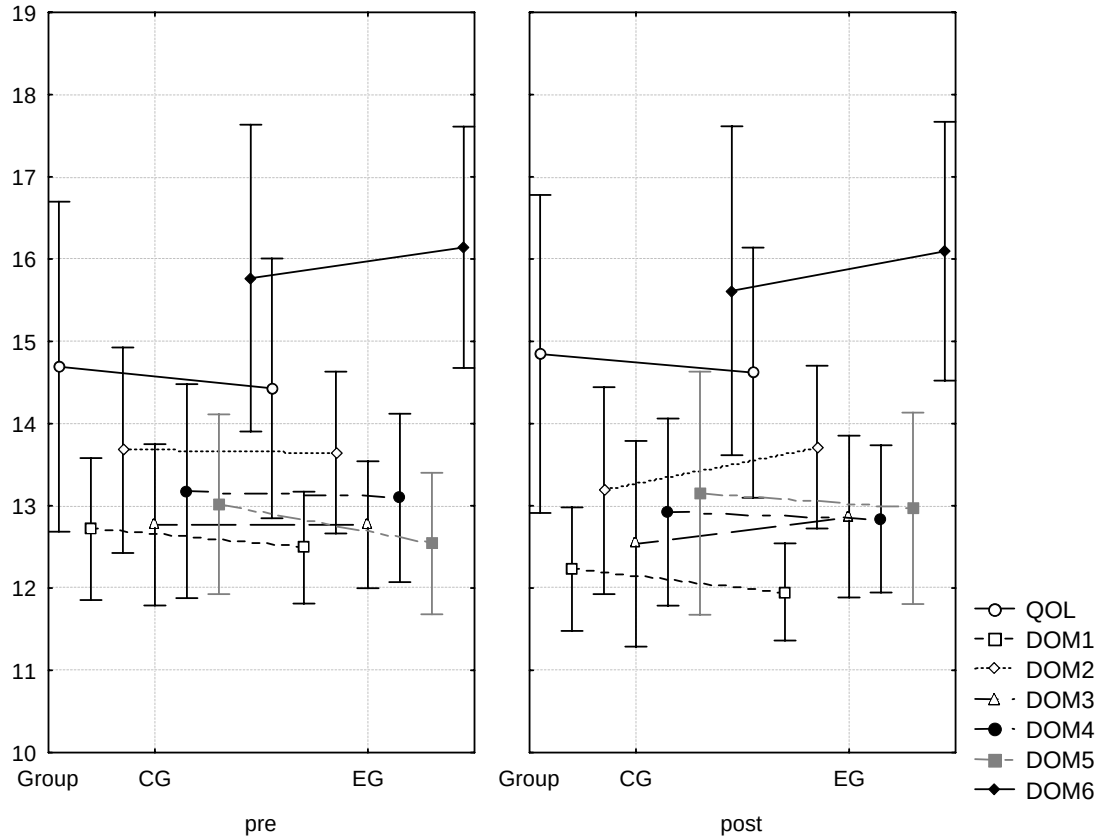

Figure 2: Interaction of the inspiratory muscular strengthening with the QOL and the diverse domains (DOM1 to the DOM6) of the quality of life of questionnaire WHOQOL-100.

Wilks lambda = 0,96 , F(7 , 26) = 0,15 , p = 0,99

Discussion

Katsura et al. (2005) observed that dyspnea was the most important determinant factor of quality of life in patients with COPD. This data is partially relevant for the results of our study since, despite the increase in MIP as a consequence of inspiratory muscle strengthening, such optimization did not translate into improvement in the quality of life (figure 1).

This study demonstrated that there was a significant difference in post-test MIP values in the experimental group using respiratory training with high load. These data are similar to those found by Sturdy et al. (2003). They used a high percentage of inspiratory muscular training in patients with COPD (70% of MIP) for 8 weeks. There was a significant increase ($p < 0.05$) in MIP and quality of life.

There are several protocols to evaluate quality of life. The short-form 36 – SF-36 (De Vet et al., 2005) is used to evaluate quality of life in most studies. Mahler & Mackowiak (1995) could validate this test as a useful tool in evaluating quality of life in patients with COPD. Therefore, it is interesting to emphasize the choice of the WHOQOL-100 in our study to obtain a wider range of information. But it is important to point out that an extensive and qualitative instrument such as the questionnaire used in this study can result in answers with different connotations, interpretations, and perceptions, which makes it difficult to find correlations and significant results.

Despite the efficacy of the drug therapy in patients with asthma, Weiner et al. (2002) performed a random study to evaluate the effects of inspiratory muscle strengthening on MIP, use of β2 agonists, and dyspnea in asthma patients. Their results demonstrated: a significant increase in MIP ($p < 0.01$); a decrease in the use of β2 agonists ($p < 0.001$); and a decrease in the perception of dyspnea ($p < 0.001$). Despite the fact that in our study the improvement in MIP after inspiratory muscle strengthening showed the same tendency, which can be seen in figure 1, and that this optimization of MIP resulted in a decrease in dyspnea, which has a close relationship with quality of life (Katsura et al., 2005), our study did not find a significant improvement in the post-test quality of life. However, unlike the study of Wiener et al. (2002), we did not use a questionnaire developed specifically for elderly patients.

We observed a significant reduction in MIP secondary to the aging process, which is worse when associated with a sedentary life style, and Tables 1 and 2 show a low (Neder et al., 1999) pre-test MIP in EG and low pre- and post-test MIP in CG. These data are similar to the results of other studies (Pine et al., 2005; Tolep et al., 1997). However, the study of Chaunchaiyakul et al. (2004) contradict our results, since they did not find, in several age groups, significant differences in the work of the inspiratory muscles between sedentary individuals and those who engage in regular physical activities. Besides, they did not find a

significant improvement when regular physical activities were introduced. The authors found a significant difference with aging only for the elastic properties of the lungs and chest wall.

Although we observed that a regular physical activity, in this case the strengthening of the inspiratory muscles, resulted in an increase in maximal inspiratory pressure in EG when compared to CG (Figure 1), the study of Marcell (2003) does not confirm our results. They observed that the sarcopenia is similar between elderly individuals who engage in regular physical activities and sedentary individuals.

In order to investigate the influence of inspiratory muscle training in the psychosocial status of individuals with cystic fibrosis, Enright et al. (2004) divided, randomly, the study cohort in 3 groups: Training group, with 80% of MIP (G1, n = 9); placebo group with 20% of MIP (G2, n = 10); and control group (G3, n = 10). They observed an increase in MIP ($p < 0.05$) in G1 and G2; however, only G1 presented a concomitant improvement of anxiety ($p < 0.05$) and depression ($p < 0.01$). These data are not similar to ours, since we did not find significant improvement in DOM2 of the WHOQOL-100.

The results of Laoutaris et al. (2004) support our findings because through inspiratory muscular training using the Threshold in patients with CHF, with a load corresponding to 60% of MIP, they found a significant improvement in MIP ($p < 0.001$). However, those authors also found a significant improvement in dyspnea according to the Borg scale ($p < 0.005$) and in quality of life ($p < 0.01$). Although those results go against the results in Figure 2 regarding quality of life, it should be emphasized that the present study found limitations regarding an ideal questionnaire to evaluate the study population, since there are no quality of life questionnaires to evaluate the elderly. This information is even more relevant because the elderly are unique, they live in nursing homes and have a different cultural characteristic.

Conclusions

After analyzing the results, we concluded that the isolated strengthening of the inspiratory muscles improved MIP in EG. Although several studies have shown that the optimization of MIP improves quality of life, this was not the case of the elderly nursing home patients evaluated here. However, we should point out that besides being extensive and qualitative, which could result in answers with different connotations, interpretations, and perceptions, making it difficult to find significant correlations and results, the WHOQOL-100 questionnaire is not specific for the elderly, especially when they present different cultural characteristics, since they live in nursing homes.

Further studies with elderly individuals, especially those living in nursing homes, are necessary to validate a specific questionnaire for this population.

References

Chaunchaiyakul, R., Goeller, H., Clarke, J.R. and Taylor, N.A.S. (2004). The impact of aging and habitual physical activity on static respiratory work at rest and during exercise. *Am J Physiol Lung Cell Mol Physiol* 287, 1098-106.

Cimen, O.B., Ulubas, B., Sahin, G., Calikoglu, M., Bagis, S. and Erdogan, C. (2003). Pulmonary function tests, respiratory muscle strength and endurance of patients with osteoporosis. *South Med J,* 96(5), 423-426.

Covey, M.K., Larson, J.L., Wirtz, S.E., Berry, J.K., Pogue, N.J. and Alex, C.G. (2001). High-intensity inspiratory muscle training in patients with chronic obstructive pulmonary disease and severely reduced function. J *Cardiopulm. Rehabil,* 21(4), 231-440.

De Vet, H.C.W., Ader, H.J., Terwee, C.B. and Pouwer, F. (2005). Are factor analytical techniques used appropriately in the validation of health status questionnaires? A systematic review on the quality of factor analysis of the SF-36. *Qual Life Re,s* 14(6), 1203-1218.

Enright, S., Chatham, K., Ionescu, A.A., Unnithan, V.B. and Shale, D.J. (2004). Inspiratory Muscle Training Improves Lung Function and Exercise Capacity in Adults with Cystic Fibrosis. *Chest,* 126, 405-411.

Fleck, M.P.A., Borges, Z.N., Bolognesi, G. and Rocha, N.S. (2003). Desenvolvimento do WHOQOL , módulo espiritualidade, religiosidade e crenças pessoais. *Rev Saúde pública,* 37(4), 446-455.

Fregonezi, G.A.F., Resqueti, V.R.R., Guell, R., Pradas, J. and Casan, P. (2005). Effects of 8-week, interval-based inspiratory muscle training and breathing retraining in patients with generalized myasthenia gravis. *Chest,* 128,1524-1530.

Gerritsen, D.L., Steverink, N., Ooms, M.E. and Ribbe, M.W. (2004). Finding a useful conceptual basis for enhancing the quality of life of nursing home residents. *Qual Life Res,* 13, 611-624.

Green, M., Road, J., Sieck, G.C. and Similowski, T. (2002). Tests of Respiratory Muscle Strength. *Am J Respir Crit Care Med,* 166, 528-547.

Guimarães, L.H.C.T., Galdino, D.C.A., Martins, F.L.M. and Abreu, S.R. (2004). Avaliação da capacidade funcional de idosos em tratamento fisioterapêutico. *Revista Neurociências,* 12(3), 1-6.

Ide, M.R., Belini, M.A.V. and Caromano, F.A. (2005). Efect of na aquatic versus non-aquatic respiratory exercise program on the respiratory muscle strength in healthy aged persons. *Clinic,* 60(2), 151-158.

Katsura, H., Yamada, K., Wakabayashi, R. and Kida, K. (2005). The impact of dyspnoea and leg fatigue during exercise on health-related quality of life in patients with COPD. *Respirology,* 10, 485-490.

Klefbeck, B. and Hamrah-Nedjad, J. (2003). Effect of inspiratory muscle training in patients with multiple sclerosis. *Arch Phys Med Rehabil,* 84(7), 994-999.

Kraemer, W.J., Koziris, L.P., Ratamess, N.A., Hakkinen, K., Triplett-McBride, N.T. and Fry, A.C. (2002). Detraining produces minimal changes in rhysical performance and hormonal variables in recreationally strength-trained men. *Journal Strength and Conditioning Research,* 16(3), 373-382.

Laoutaris, I., Dritsas, A., Brown, M.D., Manginas, A., Alivizatos, P.A. and Cokkinos, D.V. (2004). Inspiratory muscle training using an incremental endurance test alleviates dyspnea and inproves functional status in patients with cronic heart failure. *Eur J Cardiovasc Prev Rehabil,* 11(6), 489-496.

Liaw, M.Y., Lin, M.C., Cheng, P.T., Wong, M.K. and Tang, F.T. (2000). Resistive inspiratory muscle training: its effectiveness in patients with acute complete cervical cord injury. *Arch Phys Med Rehabil,* 81(6), 752-756.

Mahler, D.A. and Mackowiak, J.I. (1995). Evaluation of the short-form 36-item questionnaire to measure health-related quality of life in patients with COPD. *Chest,* 107(6), 1585-1589.

Manzini, D.M., Henson, D., La MJ, et al. (1995). Benefit of selective respiratory muscle training on exercise capacity in patients with chronic congestive heart failure. *Circulation,* 91, 320-329.

Marcell, T.J. (2003). Sarcopenia: causes, consequences and preventions. *Biological Sciences and medical Sciences,* 58, M911-M916.

Neder, J.A., Andreoni, S., Lerario, M.C. and Nery, L.E. (1999). Reference values for lung function tests. II. Maximal respiratory pressures and voluntary ventilation. *Braz J Med Biol Res,* 32(6), 719-727.

Organização Mundial de Saúde - OMS – Divisão de Saúde Mental – Grupo WHOQOL (1998). Versão em português dos instrumentos de avaliação de Qualidade de Vida (WHOQOL). Disponível em: http://www.ufrj.br/psiq/whoqol.html.

Pine, M.J., Murphy, A.J. and Watsford, M.L. (2005). Role of respiratory system function in the age-related decline of human functional capacity. *Australasian Journal on Ageing,* 24(3), 153-156.

Steiner, M.C. and Morgan M.D.L. (2001). Enhancing physical performance in chronic obstructive pulmonary disease. *Thorax,* 56, 73-77.

Sturdy, G., Hillman, D., Green, D., Jenkins, S., Cecins, N. and Eastwood, P. Feasibility of High-Intensity Interval-Based Respiratory Muscle Training in COPD. *Chest,* 123, 142-150.

Thomas, J.R. and Nelson, J.K. (2002). *Métodos de pesquisa em atividade física*. (3ª ed.). Porto Alegre: Artmed.

Tolep, K., Higgins, N., Muza, S., Griner, G. and Kelsen, S.G. (1997). Comparison of diaphragm strength between healthy adult elderly and young men. *Am J Respir Crit Care Med,* 152(2), 677-682.

Uijl, S.G., Houtman, S., Folgering, H.T.M. and Hopman, M.T.E. (1999). Training of the respiratory muscles in individuals with tetraplegia. *Spinal Cord,* 37(8), 575-579.

Van-Der-Esch, M., Van-T-Hul, A.J., Heijmans, M. and Dekker, J. (2004). Respiratory muscle performance as a possible determinat of exercise in patients with ankylosing spondylitis. *Aust J Physiother,* 50(1), 41-45.

Volianitis, S., McConnell, A.K. and Jones, D.A. (2001). Assessment of maximum inspiratory pressure: prior submaximal respiratory muscle activity (warm-up) enhances maximum inspiratory activity and attenuates the learning effect of repeated measurement. *Respiration,* 68(1), 22-27.

Weiner, P., Magadle, R., Beckerman, M. and Bear-Yanay, N. (2002). The relationship among inspiratory muscle strenght, the perception of dyspnea and inhaled beta2-agonist use in patients with asthma. *Can Respir J,* 9(5), 307-312.