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Effect of Isometric Strength Training on Blood Pressure: Systematic Review of Literature with Specific Emphasis on Indians

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Abstract

Aim: To systematically review and report the articles on isometric exercise on blood pressure. **Method:** Study was done on February 2016 in Google Scholar using search terms 'Isometrics' and 'Blood pressure' AND 'India'. 420 articles were initially identified and after inclusion, exclusion criteria 3 articles are used for this review. **Results:** Studies were at least 5 weeks duration with 30% MVIC (maximum voluntary isometric contraction) of intensity for 3 min duration. Total of 110 subjects participated with median of 30 subjects. Garg et al. (2014) found mean difference (MD) of -9.87 mmHg in SBP and -5.26 mmHg in DBP. Sandhu et al. (2014) found MD of -7.04 mmHg in SBP and -6.56 mmHg in DBP. Gandhi (2016) found MD of -3.24 mmHg in SBP and -4.03 mmHg in DBP. Overall there was a mean reduction of 6.72 mmHg in SBP and 5.28 mmHg in DBP. **Conclusion:** After isometric exercise in Indians BP reduction is as of Western counterparts**.**

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Introduction

High blood pressure (BP) is ranked as the third most important risk factor for burden of disease in south Asia (Lim et al., 2012). Overall prevalence for hypertension in India was 29.8%. Significant differences in hypertension prevalence were noted between rural and urban parts [27.6% and 33.8%]. Of these, 25% rural and 42% urban Indians are aware of their hypertensive status. Only 25% rural and 38% of urban Indians are being treated for hypertension. One-tenth of rural and one-fifth of urban Indian hypertensive population have their BP under control (Anchala et al., 2014). Studies reported on the risk factors associated with HTN in Indians include age, alcohol, smoking and chewing tobacco, BMI, central obesity (defined as waist circumference >90 cm in men and >80 cm in women), consumption of low vegetables/fruits, high consumption of dietary fat and salt, and physical inactivity (Laxmaiah et al., 2015; Anchala et al., 2014). Antihypertensive therapy alone has failed to reduce blood pressure to greater extent. Hence, life style modification is the first line treatment of choice in high normal or stage I hypertensive patients. Promoting physical activity, quitting the smoking, alcohol reduction, salt reduction in diet, stress reduction are some of the life style modifications that proven to reduce blood pressure (Vandana et al., 2016). Exercises are better than pharmacological

treatment as they don't have any known side effects and they are cheap, easy to administer. There are four main types of exercises that reduce the blood pressure to the extent of pharmacological interventions. They are physical activity such as walking, cycling etc., aerobic exercise, resistance exercise and isometric exercise (Kulandaivelan et al., 2016). Isometric hand grip exercise, a form of simple, static resistance exercise, has shown to reduce blood pressure to the greater extent than that of other forms of exercise. A recent meta-analytical study that compares all forms of exercise concluded that isometric exercise is the best form of exercise to contain the blood pressure (Cornelissen and Smart, 2013). These meta-analytical studies are mainly based on western population. In India, very few studies have been done to investigate the effect of exercise, aerobics, resistance and isometric, on blood pressure. Thus the primary objective of present review was to see the effect of isometric exercise on blood pressure in Indian population. Then to compare these results with international studies.

Materials & Method

This review was done between January and February, 2016. We comprehensively searched 'Google Scholar' search engine for relevant articles. The following search terminology was used to identify articles: "Isometric Exercise" AND "Blood Pressure" AND "India". 420 articles were identified in Google Scholar. Inclusion criteria for the selection of the present review are full text articles in English; intervention should be of at least 4 weeks; articles should be from India; subjects should be either normotensive or hypertensive individuals. Animal studies, review articles, subjects with other pathological condition were excluded. Studies using intervention other than isometric exercise were excluded. 3 articles met the inclusion criteria. In order to compare our results with international studies, we selected 4 meta-analytical studies (Carlson et al., 2014; Cornelissen and Smart, 2013; Kelley and Kelley, 2010; Owen et al., 2010). We selected all articles included in these meta-analyses for our review. Total 10 articles were identified and we could find only 8 full text articles. We screened references of 8 full text articles for further articles related to isometric training on blood pressure. We identified 9 more articles (8 articles with full text). We included 5 articles which showed changes in SBP and DBP values after isometric training. Overall 13 articles, 18 study groups, included in this review (7 articles from Canada, 4 articles from UK and 2 articles from US; 8 articles from normotensives [10 study groups] and 5 articles from hypertensive [8 study groups] patients).

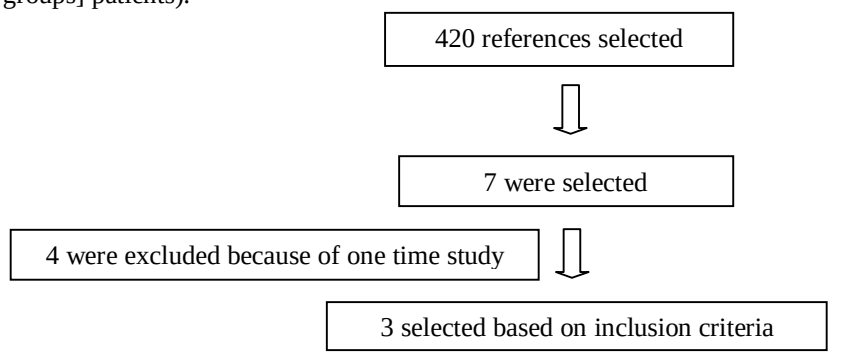

Figure 1. Schematic diagram of search methodology in Google Scholar

Results

Isometric exercise is a type of exercise in which the contraction of muscle occurs without change in length of muscles. It is type of static exercise in which muscles contract without any movement at joint. We selected total of 3 articles with 140 normotensive subjects for this review. All the 3 articles are from northern India, 2 from Uttar Pradesh and 1 from Himachal Pradesh. All articles are recent one, at least 2014 or latter. Garg et al., 2014 investigated the effects of isometric exercise training on resting blood pressure in 30 normal adults aged 20-40 years. Isometric hand grip exercise training protocol consisted of five 3- min bouts of exercise at 30% MVC (Maximum Voluntary Contraction) separated by 5 minute rest periods. Exercise was performed 3 times per week for 10 weeks. There was a significant reduction in resting blood pressure following 10 weeks of exercise training. SBP reduced from 122.67 mmHg to 112.8 mmHg and DBP reduced from 81.73 mmHg to76.47 mmHg. They found mean difference (MD) of -9.87 mmHg for SBP and -5.26 mmHg for DBP. Sandhu et al., 2014 evaluated the effect of isometric exercise training on blood pressure in 50 normotensive individuals aged 19-35 years. Isometric handgrip training was imparted to 25 individuals for 8 weeks with increment in intensity every 2 week. They stated that after 2 weeks of training results was non-significant but after 6 and 8 weeks of training, there was a significant reduction in both SBP as well as DBP in experimental group as compared to control group. They found MD of -7.04 mmHg in SBP and -6.56 mmHg in DBP. Gandhi 2016 studied the effect of isometric hand grip exercise training of 5 weeks on cardiovascular and echocardiographic parameters among healthy males. Subjects were asked to perform 4 isometric handgrip exercises at 30% of MVC for 3 minutes with 5 minutes rest in between. The frequency of exercise was 4 days per week for a period of 5 weeks. Cardiovascular parameters were recorded at the start (pre) and at the end (post) of the training. Resting SBP reduced from 108.97 to 105.73 mmHg (MD -3.24 mmHg) and DBP reduced from 69.03 to 65.00 mmHg (MD -4.03 mmHg).International studies reported mean reduction of 7.14 mmHg in SBP and 2.74 mmHg in DBP (n=18). Hypertensive patients showed more reduction in SBP than normotensive subjects (7.76 mmHg Vs 6.65 mmHg for hypertensive, normotensive subjects respectively). However, there was no such difference in DBP values (2.71 mmHg Vs 2.77 mmHg for hypertensive, normotensive subjects respectively). Majority of the included studies were 8 weeks in duration (13 out of 18 study groups). They reported a mean reduction of 6.92 in SBP and 2.15 in DBP. There was no association between duration of intervention and BP reduction. Hand grip exercise seems to be superior to that of leg press exercise in hypertensive subjects (Howden et al., 2002). 3 sessions per week is superior to that of 5 sessions per week (Badrov et al., 2013a) and followed by most of the studies.

Table 1. Summary of isometric exercise training on blood pressure

Author Year	Type of study Sample size Duration	Pre SBP (mm Hg)	Post SBP (mmHg)	Pre DBP (mmHg)	Post DBP (mmHg)	Mean Difference (MD) mmHg
Indians						
Sandhu et al., 2014	Experimental study 50 normotensives 8 Weeks	112.08 ± 4.45	105.04 ± 4.55	70.64 ± 4.95	64.08 ± 4.43	SBP -07.04 DBP -06.56
Garg et al , 2014	Experimental study 30 healthy adults 10 Weeks	122.67 ± 2.31	112.8 ± 1.86	81.73 ± 2.66	76.47 ± 3.00	SBP -09.87 DBP -05.26
Gandhi, 2016	Experimental study 30 healthy males 5 Weeks	108.97 ± 7.29	105.73 ± 6.83	69.03 ± 5.99	65.00 ± 6.74	SBP -03.24 DBP -04.03
Internationals						
Ray and Carrasco, 2000	Experimental Study 24 normotensives 5 Weeks	116.00 ± 3.00	113.00 ± 2.00	86.00 ± 1.00	82.00 ± 1.00	SBP -03.00 DBP -04.00
Howden et al., 2002	Experimental Study 27 subjects T1 and T2* 5 Weeks each	T1 120.7 ±9.6 T2 114.3 ±11.3	T1 110.7±8.4 T2 101.9±7.7	T1 70.3 ± 7.4 T2 64.8 ± 5.6	T1 66.7±11.2 T2 58.8±12.3	SBP T1 - 10.0 T2 -13.4 DBP T1 - 03.6 T2 -06.0
McGowan et al., 2007a	Experimental Study 11 subjects 8 Weeks	118.1 ± 2.4	113.2 ± 1.3	64.2 ± 2.2	64.1 ± 1.2	SBP -04.90 DBP -00.10
McGowan et al., 2007b	Experimental Study 16 hypertensives 8 Weeks	Uni 141.6 ±3.8 Bi 133.9 ±5.0	Uni 132.4±4.4 Bi 118.5±4.0	Uni 79.6±3.8 Bi 73.2±3.2	Uni 76.0±3.1 Bi 67.2±3.4	SBP Uni -09.20 Bi -15.40 DBP Uni -03.60 Bi -06.00
Millar et al., 2008	Experimental Study 49 normotensives 8 Weeks	122.0 ± 3.0	112.0 ± 3.0	70.0 ± 1.0	67.0 ± 1.0	SBP -10.00 DBP -03.00
Wiles et al., 2010	Experimental Study 33 healthy males HI and LI 8 Weeks	HI 121.5 ±4.6 LI 118.0 ±10.1	HI 116.3±6.9 LI 114.3±8.6	HI 68.5 ± 4.6 LI 69.6 ± 9.7	HI 65.8 ± 3.2 LI 67.1 ± 8.3	SBP HI -05.20 LI -03.70 DBP HI -02.70 LI -02.50
Devereux et al., 2011	Experimental Study 13 normotensives 4 Weeks	119.9 ± 11.6	115.0 ± 11.5	69.0 ± 4.4	66.2 ± 5.0	SBP -04.90 DBP -02.80
Baross et al., 2012	Experimental Study 30 middle aged men HI and LI 8 Weeks	HI 138.7 ±7.0 LI	HI 127.9±8.0 LI 136.5±5.9	HI 78.2±5.5 LI 78.3±5.5	HI 76.6±7.4 LI 79.4±5.6	SBP HI -10.80 LI -0.80 DBP

		137.3 ±5.3				HI -01.60 LI +01.10
Millar et al., 2012	Experimental Study 23 hypertensives 8 Weeks	125 ± 3	120 ± 2	73 ± 2	70 ± 3	SBP -05.00 DBP -03.00
Stiller-Moldovan et al., 2012	Experimental Study 20 hypertensives 8 Weeks	127.4 ± 10.1	125.5 ± 8.6	76.0 ± 6.0	74.4 ± 6.0	SBP -01.90 DBP -01.60
Badrov et al., 2013a	Experimental Study 32 normotensive women 8 Weeks	IHG3 94±6 IHG5 97±11	IHG3 88±5 IHG5 91±9	IHG3 57±7 IHG5 57±7	IHG3 54±6 IHG5 57±5	SBP IHG3 -06.00 IHG5 -06.00 DBP IHG3 -03.00 IHG5 00.00
Badrov et al., 2013b	Experimental Study 24 hypertensives 10 Weeks	129 ± 16	121 ± 16	72 ± 9	67 ± 8	SBP -08.00 DBP -05.00
Baross et al., 2013	Experimental Study 20 older men 8 Weeks	139 ± 6	128	85 ± 7	83	SBP -11.00 DBP -02.00

*T1, T2 means training 1 (lower leg), training 2 (hand grip) each 5 weeks duration; Uni means unilateral exercise and Bi means bilateral exercise; HI means high intensity training and LI means low intensity training; IHG3 means 3 sessions per week and IHG5 means 5 sessions per week

Discussion

The primary objective of present review was to see isometric training of at least 4 weeks duration on blood pressure in Indian adults. The results suggest that there was mean reduction of 6.72 mmHg in SBP and 5.28 mmHg in DBP. Even though we did not use any statistical tests, the results also suggest reduction in blood pressure is duration of exercise dependent especially in SBP. Results are comparable to each other since the intensity exercise is same in all three articles (30% MVC).

Use of isometric exercise as a training modality to reduce blood pressure is relatively new phenomenon even in western population. Majority of publications are published after 2008 and reported a significantly higher reduction in BP than other type of training (i.e) aerobics, physical activity or dynamic resistance exercise. In a recent meta-analysis of 9 articles, Carlson et al., 2014 reported MD of -6.77 mmHg in SBP and -3.96 mmHg in DBP. Present review finding is similar for SBP and slightly higher for DBP. However, recent review on meta-analytical studies (total 3) Kulandaivelan et al., 2016 found MD of -10.13 mmHg in SBP and -5.84 mmHg in DBP after isometric exercise training. Based on this our present review is slightly higher for SBP and similar for DBP.

Significant of this review is mean reduction of 6.0 mmHg in SBP could reduce mortality from coronary heart disease (CHD) by 12%, stroke by 18% (Stamler et al., 1989). Another study found that rise of SBP by 6.0 mmHg and DBP by 4.6 mmHg would result in estimated 24% increased risk for CHD and 48% increased risk for stroke (Poirier et al., 2006). These findings suggest that isometric training could be used as a preventive measure in young adults to counter future risk of hypertension. The important point to be noted here is that the volume of isometric exercise (15 minutes) used in these articles are much lesser than that of other type of exercises. Main limitation of this review is only 3 articles included for the review and all are from northern India. Another drawback is only

one articles is from quality journal. We suggest that future studies should be conducted from other parts of India and the authors should publish in quality journals. All articles used same intensity of exercise for same duration. Future studies should focus to alter the determinants of exercise (i.e) intensity, volume and duration etc.

Conclusion

The present review conclude that isometric exercise training reduce the blood pressure in Indians that is similar to the findings of western population. So, health care practitioners should prescribe isometric exercise to young adults who are at risk of hypertension.

References

Anchala, R., Kannuri, N. K., Pant, H., Khan, H., Franco, O. H., Di Angelantonio, E., Prabhakaran, D. 2014. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. *Journal of Hypertension*, 32(6):1170-77.

Badrov, M. B., Bartol, C. L., DiBartolomeo, M. A., Millar, P. J., McNevin, N. H., McGowan, C. L. 2013a. Effects of isometric handgrip training dose on resting blood pressure and resistance vessel endothelial function in normotensive women. *Eur J Appl Physiol*, 113(8):2091-100.

Badrov, M. B., Horton, S., Millar, P. J., McGowan, C. L. 2013b. Cardiovascular stress reactivity tasks successfully predict the hypotensive response of isometric handgrip training in hypertensives. *Psycho physiology*, 50(4):407-414.

Baross, A. W., Wiles, J. D., Swaine, I. L. 2012. Effects of the intensity of leg isometric training on the vasculature of trained and untrained limbs and resting blood pressure in middle aged men. *International Journal of Vascular Medicine*, ID 964697, 8 pages.

Baross, A. W., Wiles, J. D., Swaine, I. L. 2013. Double-leg isometric exercise training in older men. *Open Access J Sports Med*, 4:33-40.

Carlson, D. J., Dieberg,G., Hess, N. C., Millar, P. J., Smart, N. A. 2014. Isometric Exercise Training for Blood Pressure Management: A Systematic Review and Meta-analysis. *Mayo Clin Proc*, 89(3):327-34.

Cornelissen, V. A., Smart, N. A. 2013. Exercise training for blood pressure: A systematic review and meta-analysis. *J Am Heart Assoc*, 2:e004473. DOI: 10.1161/JAHA.112.004473.

Devereux, G. R., Wiles, J. D., Swaine, I. 2011. Markers of isometric training intensity and reductions in resting blood pressure. *J Sports Sci*, 29(7):715-724.

Gandhi, S. 2016. Effect of isometric hand grip exercise training on cardiovascular and echocardiographic parameters among healthy young males. *J Evid Based Med Healthc*, 3(1):24-29.

Garg, R., Malhotra, V., Kumar, A., Dhar, U., Tripathi, Y. 2014. Effect of Isometric Handgrip Exercise Training on Resting Blood Pressure in Normal Healthy Adults. *Journal of Clinical and Diagnostic Research*, 8(9):BC08-BC10.

Howden, R., Lightfoot, J. T., Brown, S. J., Swaine, I. L. 2002. The effects of isometric exercise training on resting blood pressure and orthostatic tolerance in humans. *Exp Physiol*, 87(4): 507–515.

Kelley, G.A., Kelley, K.S. 2010. Isometric handgrip exercise and resting blood pressure: A meta-analysis of randomized controlled trials. *Journal of Hypertension*, 28(3):411-18.

Kulandaivelan, S., Verma, S. K., Punia, S. 2016. *Effect of Exercise or Physical Activity on Blood Pressure in Hypertension: Evidence from Meta-analytical Studies*. Presented and Published in Conference Proceedings of 'One day National

Conference on Recent Trends in Health Care' on 14th March, 2016 at GJUST, Hisar. [Abstract No: 08; Page No: 04].

Laxmaiah, A., Meshram, I. I., Arlappa, N., Balakrishna, N., Rao, K. M., Reddy, Ch. G., Ravindranath, M., Kumar, S., Kumar, H., Brahmam, G. N. 2015. Socio-economic & demographic determinants of hypertension & knowledge, practices & risk behaviour of tribals in India.*Indian J Med Res*, 141(5):697-708.

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., Amann, M., Anderson, H. R., Andrews, K. G., Aryee, M., Atkinson, C., Bacchus, L. J., Bahalim, A. N., Balakrishnan, K., Balmes, J., Barker-Collo, S., Baxter, A., Bell, M. L., Blore, J. D., Blyth, F., Bonner, C., Borges, G., Bourne, R., Boussinesq, M., Brauer, M., Brooks, P., Bruce, N. G., Brunekreef, B., Bryan-Hancock, C., Bucello, C., Buchbinder, R., Bull, F., Burnett, R. T., Byers, T. E., Calabria, B., Carapetis, J., Carnahan, E., Chafe, Z., Charlson, F., Chen, H., Chen, J. S., Cheng, A. T., Child, J. C., Cohen, A., Colson, K. E., Cowie, B. C., Darby, S., Darling, S., Davis, A., Degenhardt, L., Dentener, F., Des Jarlais, D. C., Devries, K., Dherani, M., Ding, E. L., Dorsey, E. R., Driscoll, T., Edmond, K., Ali, S. E., Engell, R. E., Erwin, P. J., Fahimi, S., Falder, G., Farzadfar, F., Ferrari, A., Finucane, M. M., Flaxman, S., Fowkes, F. G., Freedman, G., Freeman, M. K., Gakidou, E., Ghosh, S., Giovannucci, E., Gmel, G., Graham, K., Grainger, R., Grant, B., Gunnell, D., Gutierrez, H. R., Hall, W., Hoek, H. W., Hogan, A., Hosgood, H. D. 3rd., Hoy, D., Hu, H., Hubbell, B. J., Hutchings, S. J., Ibeanusi, S. E., Jacklyn, G. L., Jasrasaria, R., Jonas, J. B., Kan, H., Kanis, J. A., Kassebaum, N., Kawakami, N., Khang, Y. H., Khatibzadeh, S., Khoo, J. P., Kok, C., Laden, F., Lalloo, R., Lan, Q., Lathlean, T., Leasher, J. L., Leigh, J., Li, Y., Lin, J. K., Lipshultz, S. E., London, S., Lozano, R., Lu, Y., Mak, J., Malekzadeh, R., Mallinger, L., Marcenes, W., March, L., Marks, R., Martin, R., McGale, P., McGrath, J., Mehta, S., Mensah, G. A., Merriman, T. R., Micha, R., Michaud, C., Mishra, V., Mohd Hanafiah, K., Mokdad, A. A., Morawska, L., Mozaffarian, D., Murphy, T., Naghavi, M., Neal, B., Nelson, P. K., Nolla, J. M., Norman, R., Olives, C., Omer, S. B., Orchard, J., Osborne, R., Ostro, B., Page, A., Pandey, K. D., Parry, C. D., Passmore, E., Patra, J., Pearce, N., Pelizzari, P. M., Petzold, M., Phillips, M. R., Pope, D., Pope, C. A. 3rd., Powles, J., Rao, M., Razavi, H., Rehfuess, E. A., Rehm, J. T., Ritz, B., Rivara, F. P., Roberts, T., Robinson, C., Rodriguez-Portales, J. A., Romieu, I., Room, R., Rosenfeld, L. C., Roy, A., Rushton, L., Salomon, J. A., Sampson, U., Sanchez-Riera, L., Sanman, E., Sapkota, A., Seedat, S., Shi, P., Shield, K., Shivakoti, R., Singh, G. M., Sleet, D. A., Smith, E., Smith, K. R., Stapelberg, N. J., Steenland, K., Stöckl, H., Stovner, L. J., Straif, K., Straney, L., Thurston, G. D., Tran, J. H., Van Dingenen, R., van Donkelaar, A., Veerman, J. L., Vijayakumar, L., Weintraub, R., Weissman, M. M., White, R. A., Whiteford, H., Wiersma, S. T., Wilkinson, J. D., Williams, H. C., Williams, W., Wilson, N., Woolf, A. D., Yip, P., Zielinski, J. M., Lopez, A. D., Murray, C. J., Ezzati, M., AlMazroa, M. A., Memish, Z. A. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, 380(9859):2224-60.

McGowan, C. L., Levy, A. S., McCartney, N., MacDonald, M. J. 2007a. Isometric handgrip training does not improve flow-mediated dilation in subjects with normal blood pressure. *Clinical Science*, 112(7-8):403–409.

McGowan, C. L., Visocchi, A., Faulkner, M., Verduyn, R., Rakobowchuk, M., Levy, A. S., McCartney, N., MacDonald, M. J. 2007b. Isometric handgrip training

improves local flow-mediated dilation in medicated hypertensives. *Eur J Appl Physiol*, 99:227–234.

Millar, P. J., Bray, S. R., MacDonald, M. J., McCartney, N. 2008. The hypotensive effects of isometric handgrip training using an inexpensive spring handgrip training device. *J Cardiopulm Rehabil Prev*, 28(3):203-207.

Millar, P. J., Levy, A. S., McGowan, C. L., McCartney, N., MacDonald, M. J. 2013. Isometric handgrip training lowers blood pressure and increases heart rate complexity in medicated hypertensive patients. *Scand J Med Sci Sports*, 23(5):620-26.

Owen, A., Wiles, J., Swaine, I. 2010. Effect of isometric exercise on resting blood pressure: A meta-analysis. *Journal of Human Hypertension*, 24:796-800.

Poirier, P., Giles, T. D., Bray, G. A., Hong, Y., Stern, J. S., Pi-Sunyer, F. X., Eckel, R. H. 2006. Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss: An update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease from the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. *Circulation*, 113, 898–918.

Ray, C. A., Carrasco, D. I. 2000. Isometric handgrip training reduces arterial pressure at rest without changes in sympathetic nerve activity. *Am J Physiol Heart Circ Physiol* 279: H245–H249.

Sandhu, J. S., Gill, H. S., Gupta, V., Gurmanpreet. 2014. Effect of Isometric Handgrip Training on Heart rate and Arterial Pressure in Normotensive Individuals. *Scholars Journal of Applied Medical Sciences*, 2(6A):2010-15.

Stamler, J., Rose, G., Stamler, R., Elliott, P., Dyer, A. & Marmot, M. 1989. INTERSALT study findings. Public health and medical care implications. *Hypertension*, 14(5), 570-7.

Stiller-Moldovan, C., Kenno, K., McGowan, C. L. 2012. Effects of isometric handgrip training on blood pressure (resting and 24 h ambulatory) and heart rate variability in medicated hypertensive patients. *Blood Press Monit*, 17(2):55-61.

Vandana, Y., Kulandaivelan, S., Verma, S. K., Yadav, R., Sharma, S. 2016. *Role of Life Style Modification on Blood Pressure: Evidence from Meta-analytical Studies*. Presented and Published in Conference Proceedings of 'One day National Conference on Recent Trends in Health Care' on 14th March, 2016 at GJUST, Hisar. [Abstract No: 21; Page No: 11].

Wiles, J. D., Coleman, D. A., Swaine, I. L. 2010. The effects of performing isometric training at two exercise intensities in healthy young males. *Eur J Appl Physiol*, 108(3):419-428.

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