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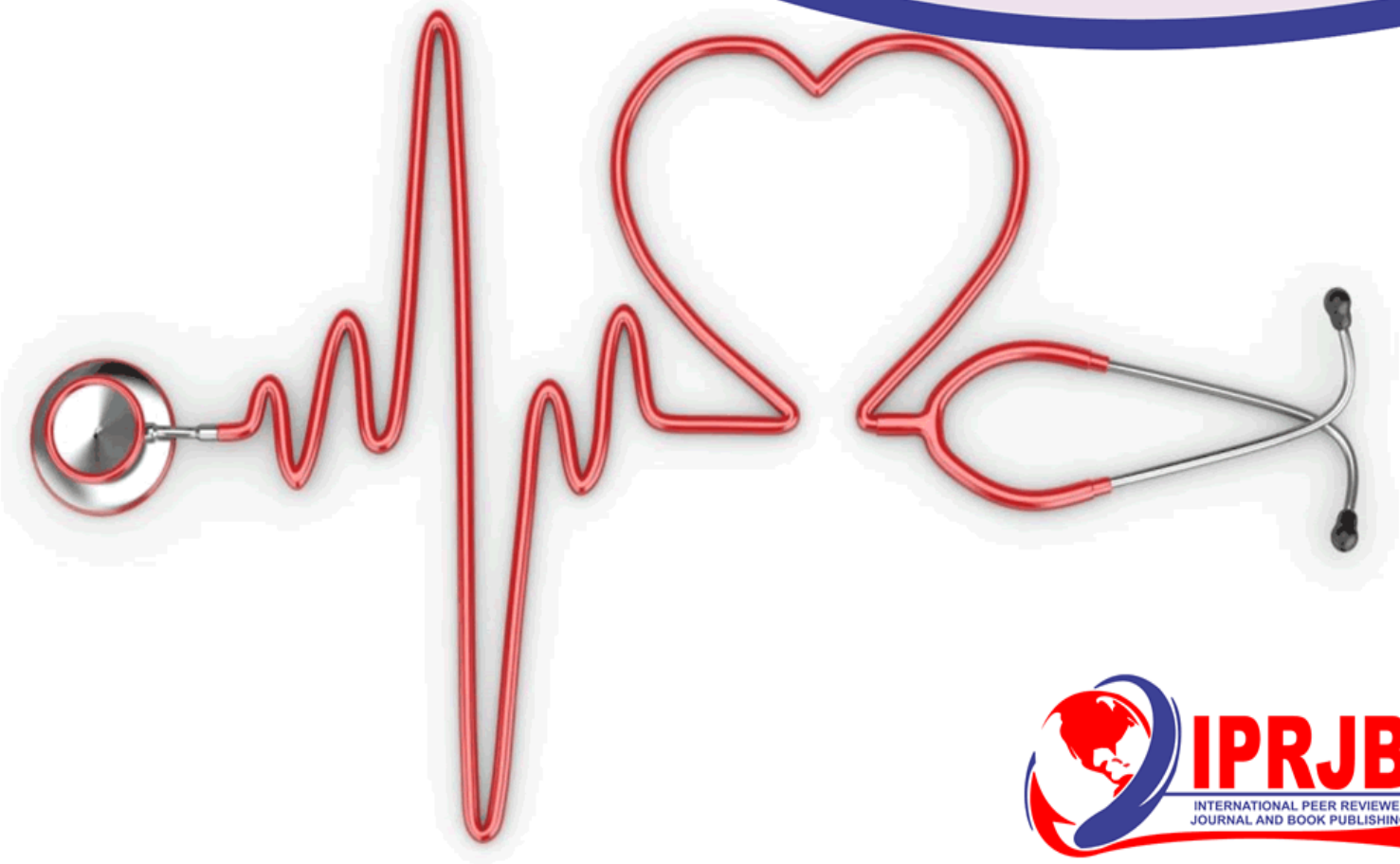

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EFFECT OF A COMBINED EXERCISE AND MAGNESIUM SUPPLEMENTATION REGIMEN ON BLOOD PRESSURE IN GRADE I HYPERTENSIVE ADULTS

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Abstract

Purpose: The main aim of the study was to assess the change in resting Blood Pressure (BP) after a 6 week combined exercise and magnesium (Mg) supplementation regimen in grade I hypertensive adults. The secondary aim of the study was to assess the change in resting Heart Rate (HR) after a 6 week combined exercise and magnesium supplementation regimen in grade I hypertensive adults.

Methodology: This study employed an experimental research design because specific conditions were controlled and its effects observed. In this case, exercise and administration of Mg was controlled by the researcher and the influences on resting BP and RHR were observed. A sample of 14 hypertensive adults was used in the study. Data was analyzed using SPSS version 25 (IBM Limited, UK, 2017) and Microsoft Excel 2013 for Windows. The significance level was set at $p<0.05$. Data was tested for normal distribution using the Shapiro-Wilk test while the Levenes test was used to test for data normality. Data was determined to be parametric. A paired t-test was used to compare mean differences from baseline, mid-point and post-test within the group.

Results: There was no significant difference observed at baseline for Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) within the exercise and magnesium supplementation group (EMG) ($p>0.05$). The EMG had a mean SBP and DBP of 145.7 ± 6.4 mmHg and 88.9 ± 5.9 mmHg at baseline. Following a combination of exercise (45 min, 5 times a week) and magnesium supplementation (500 mg/day) the mean SBP and DBP reduced by -3.6 ± 3.2 mmHg and -3.4 ± 5.1 mmHg respectively after 3 weeks and reduced further by -7.1 ± 2.1 mmHg and - 4.9 ± 4.4mmHg after 6 weeks. The changes were statistically significant ($p<0.05$) for SBP after 3weeks but not for DBP ($p>0.05$). The changes were statistically significant ($p<0.05$) for both SBP and DBP after 6 weeks.In addition, there was no significant difference observed at baseline for RHR within the EMG group ($p>0.05$).The EMG group had a mean RHR of 82.2 ± 10.7 bpm at baseline. Following a combination of exercise (45 min, 5 times a week) and magnesium supplementation (500 mg/day) the mean RHR reduced by -4.8 ± 5.9 bpm after 3 weeks and reduced further by -10.9 ± 4.0 bpm after 6 weeks. The changes were statistically significant ($p<0.05$) after 3 weeks and 6 weeks respectively.

Recommendations for practice and policy: The study findings suggests that a combination of exercise and magnesium supplementation is an alternative non-pharmacological BP management method for individuals with hypertension, therefore exercise and magnesium supplementation could be included as part of the treatment protocol for individuals with hypertension

Key Words: *Exercise, magnesium supplementation, Blood pressure, heart rate, grade 1 hypertensive adults.*

1.0 INTRODUCTION

1.1 Background of the Study

Hypertension affects 20% of the adult population worldwide and is considered to be a multi- factorial disorder of unknown etiologies (Ho, Low & Rose'Meyer, 2016). Hypertension (systolic and diastolic blood pressure ≥140/90 mmHg) has severe social, economic and human consequences particularly in poor populations such as Kenya (WHO, 2014). The WHO global status report on non-communicable diseases (2014) states that the age-adjusted prevalence of raised blood pressure amongst the adult Kenyan population is 21.1% with individuals aged 30 to 70 years having a 15-19% chance of dying from this disease. In the lower middle income countries of Sub-Saharan Africa such as Kenya, the mortality amongst patients being hospitalized for secondary diseases relating to hypertension is over 20% (Twagirumukiza and Van Bortel, 2010), thus if a major cardiovascular risk factor such as hypertension is controlled it may reduce the cardiovascular disease burden for the region

Previous studies have investigated the blood pressure response to exercise and Mg independently; however to the author's best knowledge there is no research that has been conducted on the effect of combining a chronic exercise program and Mg supplementation regimen on BP in adults with hypertension. However, two studies have investigated the effect of Mg supplementation on resting and recovery blood pressure after exercise (Kass, Skinner & Poeira, 2013; Kass & Poeria, 2015). These studies did not have any exercise intervention and were investigating acute changes in BP, while the current study had an exercise intervention and focused on chronic BP changes that occurred even after the effects of PEH have disappeared.

1.2 Statement of the Problem

Since blood pressure treatment and control is expensive, the prevalence of hypertension within lower-middle income countries (such as Kenya) has increased, consequently increasing the cardiovascular disease burden. Hypertensive individuals do not get appropriate care because they cannot afford the medication and treatment which leads to secondary cardiovascular diseases associated with raised blood pressure. The age-adjusted prevalence of raised blood pressure is 21.1% amongst the Kenyan adult population (WHO, 2014) and is on the rise (M'Buyamba-Kabangu et al., 2013). Since hypertension is a major risk factor and driving force for cardiovascular diseases, finding an economical and accessible method of controlling it may reduce the cardiovascular disease burden in Kenya. Since exercise can be conducted in any open space at no cost and magnesium supplements cost a fraction of anti-hypertensive medications, combing these two economical methods, as done in the study may be the solution that will allow increased access to hypertensive care by lowering treatment cost.

1.3 Purpose of the Study

The primary aim of the study was to assess the change in resting Blood Pressure (BP) after a 6 week combined exercise and magnesium(Mg) supplementation regimen in grade I hypertensive adults. The secondary aim of the study was to assess the change in resting Heart Rate (HR) after a 6 week combined exercise and magnesium supplementation regimen in grade I hypertensive adults.

1.4 Hypothesis

H_{01}- There is no significant difference in the changes observed in resting BP in adults with

grade I hypertension following a 6 week combined exercise and magnesium supplementation regimen.

H_{02} - There is no significant difference in the changes observed in RHR in adults with grade I hypertension following a 6 week combined exercise and magnesium supplementation regimen

2.0 LITERATURE REVIEW

Combination of Magnesium and Exercise on Blood Pressure

Although there has been comprehensive research on the effects of exercise and magnesium's independent effect of blood pressure, to the author's best knowledge there no research done on the effect of combining an exercise program and Mg supplements on BP in hypertensive individuals. However, there have been two studies conducted to investigate the effects of magnesium supplementation on recover and resting BP after exercise (Kass, Skinner & Poeira, 2013; Kass & Poeira, 2015).

The study by Kass, Skinner and Poeira (2013) was a pilot study investigating the effect of magnesium supplementation on resting and recovery SBP after aerobic or resistance exercise on normotensive individuals. The study was conducted on 16 male (19-24 years) individuals who were randomly assigned to either a 300 mg/day magnesium oxide supplementation group or a control group over duration of 14 days. The subject's performed a maximal 30 min cycle, followed three x 5 second isometric bench press, at baseline and post-test. BP was measured before the exercise, immediately after and 5 minutes after recovery. This study demonstrated that magnesium caused a reduction in SBP (-8.9 mmHg) which was higher than the reduction in the control group (0.8 mmHg, $p>0.05$).

The second study was by Kass and Poiera (2015) on 13 recreational runners; cyclists or triathletes (7 males and 6 females) over 4-week duration and investigated the effects acute (1 week) vs chronic (4 week) supplementation on recovery blood pressure following exercise. The mean age of the subjects in the chronic group was 40.8 and acute group was 35.8. Subjects were placed in either a 300mg/day magnesium supplement for 1 week or 4 week. A 40km time trial followed by an 80 % 1RM bench press was performed to exhaustion at baseline and posttest (1 week and 4 weeks for both groups) where BP measurements were taken before and after the test. The reduction in SBP (-2 mmHg and -0.7 mmHg) within acute and chronic magnesium loading groups were higher than in the control group. The conclusion from these two studies was that oral magnesium supplementation significantly reduces post exercise and resting BP.

The major difference between the two studies above (Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015) and the current study is that the two studies above were looking at the effect of magnesium supplementation on recovery exercise without providing an exercise intervention, while the current study focused on looking at whether combining and exercise program and magnesium supplementation will cause larger reduction in BP than using exercise or magnesium alone. This means that the results gathered from the two studies above (Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015) were as a result of the BP lowering mechanisms of magnesium only and not exercise.

The two studies above measured acute changes in BP with measurements being taken immediately and 5 min after exercise, which meant they were looking at the effects on post exercise hypotension. The current study focused on chronic changes in BP so as to determine whether the changes in BP were long term after the effects of post exercise hypotension have worn off, thus determining whether the protocol would assist with long term BP

management. The above studies only focused on normotensive individuals. The current study looked at this same combined effect but on individuals with grade I hypertension.

The two studies above did not determine the direct influence their magnesium supplement protocol had on blood pressure. This means that they did not determine the extent to which BP was lowered by their magnesium supplementation protocol. Since magnesium supplementation protocols affect the level of BP reduction (Banjanin & Belojevic, 2018; Rosanoff, 2013), the current study included a magnesium only group to determine the independent effects of the specific magnesium supplementation protocol on BP, which the above studies did not account for. So the results from this study may be a first of it its kind when looking at combining a magnesium supplementation protocol and an exercise regimen to enhance the BP lowering effect than using one method independently.

Combination of Exercise and Magnesium on Resting Heart Rate

Since exercise has been shown to reduce RHR (Fløtum, Ottesen, Krustrup and Mohr, 2016; Park et al., 2018; Schroeder, Welk, Franke and Lee, 2017; Silva, Lima and Tremblay, 2018) and magnesium has been shown to regulate/improve cardiovascular function (Kolte, Vijayaraghavan, Khera, Sica and Frishman, 2014), it is suggested that the combination of the two will lead to a higher reduction in RHR.

To the researcher's best knowledge there is no study looking at the effects of magnesium supplementation and exercise on RHR. However there is one study that has looked at the effects of magnesium on recovery and resting heart rate after exercise. A pilot study by Kass, Skinner and Poeira (2013) on 16 normotensive individuals investigated the relationship on the effects of Mg supplements (300 mg/day magnesium oxide) on resting heart rate (secondary outcome measure) after aerobic and resistance exercise after 14 weeks. After the 14 week intervention there was a reduction in RHR of 6 bpm in the control group and 7bpm in the supplemented group. In this study however there was no exercise protocol prescribed and rather the exercise was used at baseline and posttest suggesting that the enhanced RHR lowering effects was due to magnesium.

3.0 RESEARCH METHODLOGY

This study employed an experimental research design because specific conditions were controlled and its effects observed. In this case, exercise and administration of Mg was controlled by the researcher and the influences on resting BP and RHR were observed. A sample of 14 hypertensive adults was used in the study. Data was analyzed using SPSS version 25 (IBM Limited, UK, 2017) and Microsoft Excel 2013 for Windows. The significance level was set at $p<0.05$. Data was tested for normal distribution using the Shapiro-Wilk test while the Levenes test was used to test for data normality. Data was determined to be parametric. A paired t-test was used to compare mean differences from baseline, mid-point and post-test within the group.

4.0 FINDINGS

4.1 Blood Pressure Response to Combined Exercise and Magnesium

Changes in BP (SBP and DBP) after a 6 week combination of exercise and magnesium supplementation regimen are presented below in Figure 1.

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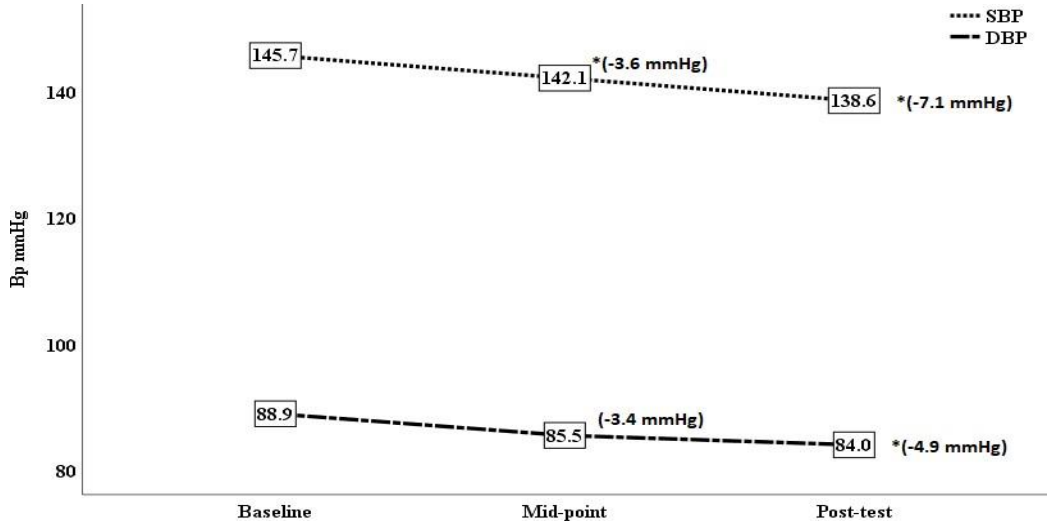

Figure 1: BP changes after 6 weeks of combined exercise and magnesium supplementation in adults with grade 1 hypertension.

There was no significant difference observed at baseline for SBP and DBP within the EMG group ($p>0.05$). The EMG had a mean SBP and DBP of 145.7 ± 6.4 mmHg and 88.9 ± 5.9 mmHg at baseline. Following a combination of exercise (45 min, 5 times a week) and magnesium supplementation (500 mg/day) the mean SBP and DBP reduced by -3.6 ± 3.2 mmHg and -3.4 ± 5.1 mmHg respectively after 3 weeks and reduced further by -7.1 ± 2.1 mmHg and - 4.9 ± 4.4mmHg after 6 weeks. The changes were statistically significant ($p<0.05$) for SBP after 3weeks but not for DBP ($p>0.05$). The changes were statistically significant ($p<0.05$) for both SBP and DBP after 6 weeks. Therefore the study rejects the null hypothesis because there was a statistically significant ($p<0.05$) reduction in resting BP (SBP and DBP) following a 6 week combined exercise and magnesium regimen in adults with grade 1 hypertension.

4.2 Heart Rate Response to Combined Exercise and Magnesium

Changes in RHR after a 6 week combination of exercise and magnesium are presented below in Figure 2.

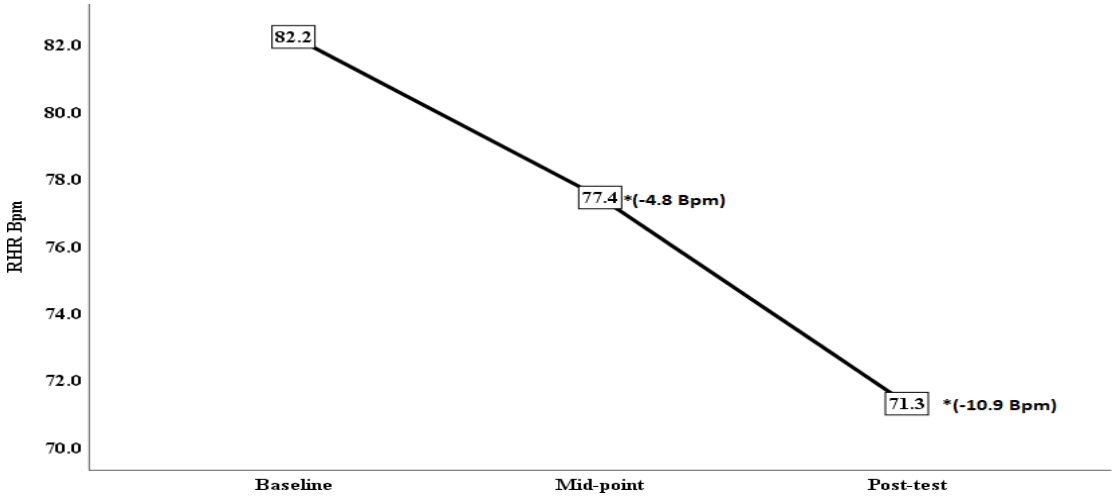

Figure 2: RHR changes after 6 weeks of combined exercise and magnesium in adults with grade 1 hypertension

There was no significant difference observed at baseline for RHR within the EMG group ($p>0.05$).The EMG group had a mean RHR of 82.2 ± 10.7 bpm at baseline. Following a combination of exercise (45 min, 5 times a week) and magnesium supplementation (500 mg/day) the mean RHR reduced by -4.8 ± 5.9 bpm after 3 weeks and reduced further by -10.9 ± 4.0 bpm after 6 weeks. The changes were statistically significant ($p<0.05$) after 3 weeks and 6 weeks respectively. Therefore the study rejects the null hypothesis because there was a statistically significant ($p<0.05$) reduction in resting RHR following a 6 week combined exercise and magnesium regimen in adults with grade 1 hypertension.

5.0 DISCUSSION OF FINDINGS

5.1 Blood Pressure Response to Combined Exercise and Magnesium

The current study found significant ($p<0.05$) reductions of -3.5 mmHg in SBP after 3 weeks and -7.1 mmHg and -4.9 mmHg in SBP and DBP respectively in the EMG group after 6 weeks. To the author's best knowledge there is no research investigating the combination of exercise and magnesium and its implication on blood pressure and therefore there is limited literature to make comparisons.

However there are two studies that investigated the effect of magnesium supplementation on resting/recovery BP after exercise (Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015). The study by Kass, Skinner and Poeira (2013) was a pilot study investigating the effect of magnesium supplementation on resting and recovery SBP after aerobic or resistance exercise on normotensive individuals. The study was conducted on 16 males (19-24 years) randomly assigned to either a 300 mg/day magnesium oxide supplementation group or a control group over a duration of 14 days. The subject's performed a maximal 30 minute cycle, followed by three x 5 second isometric bench press, at baseline and post-test. BP was measured before the exercise, immediately after and 5 minutes after recovery. This study demonstrated that magnesium caused a reduction in SBP (-8.9 mmHg) in the Mg supplemented group, which was higher than that in the control group (-0.8 mmHg, $p>0.05$).

The second study by Kass and Poiera (2015) on 13 recreational runners, cyclists or triathletes (7 males and 6 females) over a 4 week duration investigated the acute effects (1 week) vs. chronic (4 week) effect of magnesium supplementation on recovery blood pressure following exercise. The mean age of the subjects in the chronic group was 40.8 and acute group was 35.8. Subjects were placed in either a 300mg/day magnesium supplement group for 1 week or 4 weeks. A 40km time trial followed by an 80 % 1RM bench press was performed to exhaustion at baseline and post-test (1 week and 4 weeks for both groups) where BP measurements were taken before and after the test. The reduction in SBP (-2 mmHg and -0.7 mmHg) within acute and chronic magnesium loading groups were higher than in the control group. The DPB changes were -9 mmHg and-3 mmHg at rest and post exercise for both groups. The conclusion from these two studies was that oral magnesium supplementation significantly reduced post exercise and resting BP.

The major difference between the three studies (Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015) and the current study is that the two studies were looking at the effect of magnesium supplementation on recovery BP after exercise without providing an exercise intervention, while the current study focused on looking at whether combining and exercise program and magnesium supplementation would cause larger reductions in BP than using exercise or magnesium alone. This means that the results gathered from the two studies above

(Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015) were as a result of the BP lowering mechanisms of magnesium only and not exercise.

The second difference between the three studies (Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015) and the current study is that the current study focused on individuals with grade I hypertension while the studies above focused on normotensive individuals. The third difference is that the current study focused on chronic blood pressure changes that have occurred even after the effects of PEH have disappeared, while two studies (Kass, Skinner & Poeira, 2013; Kass & Poiera, 2015) focused on recovery blood pressure immediately after exercise and after 5 min, which means the effects of PEH were still current. The results of -7.1 mmHg and -4.9 mmHg in SBP and DBP in the combined exercise and magnesium group may be a first of its kind in this field of research and have added to the body of knowledge

5.2 Heart Rate Response to combined Exercise and Magnesium

The current study found a significant reduction in the mean RHR (-10.9 bpm) in the EMG group after 6 weeks. To the researcher's best knowledge there is no study looking at the effects of magnesium supplementation and exercise on RHR. However, there is one study that has looked at the effects of magnesium on recovery and resting heart rate after exercise. A pilot study by Kass, Skinner and Poeira (2013) on 16 normotensive individuals investigated the relationship on the effects of Mg supplements (300 mg/day magnesium oxide) on resting heart rate (secondary outcome measure) after aerobic and resistance exercise. After the 14 week intervention there was a reduction in RHR of -6 bpm in the control group and -7bpm in the supplemented group. In this study however there was no exercise protocol prescribed and rather the exercise was used at baseline and post-test suggesting that the enhanced RHR lowering effects was due to magnesium alone. In this study however, they did not look at changes in chronic resting heart rate, but rather changes in recovery heart rate 5 min after the exercise so it would be difficult to make comparisons based on the results.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study concluded that a combination of exercise (45 min, 5 times a week) and magnesium (500 mg/day, Mg Citrate) is an effective method of reducing blood pressure (SBP and DBP) in individuals with grade I hypertension after 6 weeks. Therefore the study rejects the null hypothesis because there was a statistically significant ($p<0.05$) reduction in resting BP (SBP and DBP) following a 6 week combined exercise and magnesium regimen in adults with grade 1 hypertension.

The study also concluded that a combination of exercise (45 min, 5 times a week) and magnesium (500 mg/day, Mg Citrate) is an effective method of reducing RHR in individuals with hypertension after 6 weeks. Therefore the study rejects the null hypothesis because there was a statistically significant ($p<0.05$) reduction in resting RHR following a 6 week combined exercise and magnesium regimen in adults with grade 1 hypertension.

Recommendations

These findings suggests that a combination of exercise and magnesium supplementation is an alternative non-pharmacological BP management method for individuals with hypertension, therefore exercise and magnesium supplementation could be included as part of the treatment protocol for individuals with hypertension. Future research could also be done on the effects of combined exercise and magnesium on individuals who have higher levels of hypertension

such as Grade 2 and Grade 3 to determine whether the effect is larger in view of the fact that these individuals are most likely to be sedentary and have hypo-magnesium.

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