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Original Research

Muscle Sentry® has No Effect on Total Work Performed and Estimated MVO_2 after High Intensity Short Duration Resistance Training

JUNHAI XU†[1], TYLER M. FARNEY †[1, 2], and ARNOLD G. NELSON‡[1]

[1]School of Kinesiology, Louisiana State University, Baton Rouge, LA, USA; [2]Department of Health & Kinesiology, Texas A&M University-Kingsville, Kingsville, TX, USA

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 13(2): 744-754, 2020. Supplements are widely used in recreational and professional participants; however, their claimed benefits are hardly to test. This study compared the total lifted numbers and post-exercise estimated MVO_2 while subjects were treated with either Muscle Sentry® (MS) or placebo (PL), in a 7-day washout period. Participants (11 women, 10 men, 20-24 years) performed 3 sets to failure chest and leg press exercises at 8 RM with 2 min rest between sets. Each exercise was performed four times (2 × MS, 2 × PL) at the same time of the day separated by 48 h. The supplementation was ingested 40 min prior to perform the exercise. Prior to the exercise and immediately after each set, both HR and BP were obtained. The rate pressure product (RPP) was then calculated to determine estimated MVO_2. Daily RPP and total weight lifted (chest + leg) for each supplementation were averaged. Normalized RPP was the ratio of averaged RPP and averaged total weight lifted. No treatment effect on chest, leg and total lift numbers, normalized post RPP (NPRPP), normalized RPP_{diff} ($NRPP_{diff}$) (p=0.94, 0.86, 0.87, 0.87, 0.43 respectively); No treatment effect on total lift numbers, NPRPP, $NRPP_{diff}$ for gender (p=0.87, 0.95, 0.96 respectively). Ingestion of Muscle Sentry® 40 min prior to do 3 sets to failure of both chest and leg presses had no effect upon either total lift numbers or estimated MVO_2. This suggests that, in some instances, the benefits of Muscle Sentry® are less than those claimed by the manufacturer.

KEY WORDS: Muscle Stamina, Lactate Salts Supplementation, Red Cinchona Bark Powder

INTRODUCTION

Our laboratory recently published a study that determined if Muscle Sentry® (Muscle Sentry LLS, Cleveland, OH) would increase muscle stamina (i.e. endurance) on both the basis of a single task and a repeated task (2). The main finding from that investigation was that the number of lifts did not differ between the Muscle Sentry® and placebo treatments for either the initial or the repeated sets. Thus, it appeared that the Muscle Sentry® had no influence upon stamina when doing a task designed to fatigue a muscle after 2 minutes of work.

In retrospect, since some of the ingredients (Table 1.) found in this supplement have shown positive effects in work of short duration and higher intensity, it is still possible that this supplement will have an effect if used in different work scenarios. Muscle Sentry® purported benefits upon stamina arise from ingredients that include various minerals complexed with

lactate and red cinchona bark powder, a source of quinine. Morris (14) has pointed out that exogenous lactate could be used as an energy substrate and as a buffering agent. Moreover, ingestion has been shown to increase blood pH, bicarbonate levels and increase time to exhaustion in short, high-intensity work bouts. On the other hand, Muscle Sentry® is unique in that it contains red cinchona bark powder, a source of quinine. Gam et al. (5) have shown that ingesting a 2mM solution of quinine improved the mean power output during a 30 s cycling sprint.

Given that the ingredients found in Muscle Sentry® have been found to be beneficial in intense work bouts lasting ≤30 seconds, it is quite possible that the negative findings of our original study were due to the work lasting two minutes or 2.5 times longer than previous studies that showed positive effects. Therefore, the purpose of this study was to investigate the effects of Muscle Sentry® upon the amount of total lift numbers on repeated high-intensity short duration work. In addition, since Muscle Sentry® manufacturer's claim that using this supplement leads to increased cardiovascular efficiency, we also investigated the supplement's effect upon myocardial work. In this context, we hypothesized that intake of Muscle Sentry® would increase total muscle lift numbers and estimated MVO_2.

Table 1. Muscle Sentry® active ingredients.

Supplement	Serving Amount
Niacin	50 mg
Pyridoxine HCL (vitamin B6)	9 mg
Calcium Lactate	32.5 mg
Magnesium Lactate	50 mg
Zinc Oxide	25 mg
Manganese Lactate	16 mg
Potassium Chloride	50 mg
Red Cinchona Bark Powder	600 mg

METHODS

Participants

Participants consisted of 11 female (age = 21 ± 1 y, height = 161 ± 8 cm, body mass = 61 ± 9 kg; mean ± standard deviation) and 10 male (age = 22 ± 1 y, height = 180 ± 4 cm, body mass = 73 ± 28 kg; mean ± standard deviation) physical education college students. Inclusion criteria: non-resistance trained, healthy, normotension (<120/80 mm Hg), no supplements or medication intake for more than one year. Exclusion criteria: pre-hypertension (between 120/80 mm Hg and 139/89 mm Hg), hypertension (>140/90 mm Hg), cardiovascular disease and/or obesity (BMI >30.0). This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (16) . Informed consent (written and verbal) was obtained from each participant before commencing the experiment, and the appropriate institutional human participant review committee approved the study. The participants were not allowed to see the results until the study was completed. The number of participants needed for a statistical power of β=0.20 was determined using an online calculation website (www.sample-size.net)

Protocol

Study Overview: Participants visited a weight room 5 times on different days separated by a minimum washout of seven days. On all experimental testing days, each participant performed 3 sets to failure on both a seated chest press and a leg press machine. The first experimental day consisted of the participants performing the chest and leg presses to determine their 8 repetitions maximum (8RM) weight. Days 2-5 consisted of doing 3 sets to failure with the 8RM weight for both chest and leg presses. An 8 RM was chosen because a common resistance training program consists of doing 3 sets of 8-10 reps. In a randomized counter-balanced manner, for two days the lifts were performed on Muscle Sentry®, while for the other two days were performed on a placebo. The dose for Muscle Sentry® was based upon body mass (i.e. 1 capsule for body weights <160 lbs.; 2 capsules for body weights between 160 lbs. and 240lbs.; and 3 capsules for body weights >240 lbs.). The placebo (powdered cellulose) consisted of the same amount of pills and these pills were similar in shape and color to Muscle Sentry®. In addition to count the total number of lifts, heart rate and blood pressure were measured at the beginning and end of each set to failure.

Muscle 8RM and Stamina Test Protocol: As stated, the first experimental testing day consisted of each participant performing an 8RM on the chest press and leg press machine. The chest press was performed seated on a Body Masters vertical chest press machine (Body Masters Sports Industries Inc., Rayne, LA, USA). The initial weight was set at 75% of body mass. After performing 8 lifts at this weight, the participant rested for two minutes with the next lift increased incrementally by multiples of 44 N (10 lbs.). Following a 2- minute rest, each succeeding 8 repetitions set was incremented by 44 N (10 lbs.) until failure to complete 8 repetitions. For all repetitions, participants were instructed to push upward until they reached full elbow extension as quickly as possible. Once full extension was reached, each person was instructed to return as quickly as possible to the starting position while making sure that the weight plates contacted the stationary (unmoved) plates.

The leg press was performed in a seated position using a Body Masters leg press machine (Body Masters Sports Industries Inc., Rayne, LA, USA). Prior to beginning the test, participants were seated in the apparatus with the seat position being adjusted so that the individuals starting knee angle approximated 60^{o}. The participants were instructed to push on the footplate until they reached full knee extension as quickly as possible. Once full extension was reached, it was instructed to return as quickly as possible to the starting position while making sure that the weight plates contacted the stationary (unmoved) plates. The initial weight was set at 150% of body mass, and the procedure was the same as that used for the chest press. The only difference was that the ensuing 8 repetitions set was increased incrementally by multiples of 66 N (15 lbs.) after each 2-minute rest.

For the subsequent 4 experimental testing days (day 2-5), participants reported to the laboratory 2 hours post-prandial and were instructed to consume either the Muscle Sentry® or placebo supplement. Following supplement consumption, all participants rested quietly in the laboratory for 40 minutes. Once the rest period was completed and depending upon which lift was scheduled to be first, participants began a standardized warm-up by performing 8-reps at

50% of their 8RM on either the chest press or leg press. Right after warmup, each participant performed 3 sets to failure using 8RM, with two minutes rest between sets. Upon completion of the 3-set lift, a 5-minute rest was taken. Once the 5 minutes rest was completed, participants performed a secondary warm-up of 8 reps at 50% of 8RM on the opposite lift from which they performed first. The same procedure was proceeded for the succeeding press. To ensure that all lifts were performed correctly and without too much rest, two members of the experimental team watched the subject to ensure their joints were full extended and then the weight plates returned to the starting position. These two investigators also ensured that each extension and flexion were done without any rest at either full extension or at weight plate touch. A third individual who was unaware of the supplement taken that day counted the number of lifts. Failure was set at the lift at which the person could not reach full (elbow or knee) extension.

Besides improving stamina, the manufacturer claims that the supplement improves cardiovascular efficiency. To test this, it was decided to compare the post-exercise rate pressure product (the product of heart rate and systolic blood pressure). The rate pressure product (RPP) has been shown to be a reliable and meaningful predictor of myocardial oxygen consumption (MVO_2) during static and dynamic exercise (18). Therefore, heart rate (HR) and blood pressure (BP) were obtained just prior to commencing and immediately after each set to failure. HR and BP were measured using an automated device (Omron BP710, Omron Healthcare Inc., Bannockburn, IL, USA) which had previously been shown to provide reliable and accurate values (17). Since HR and BP vary with work volume, for analysis the post-RPPs were normalized by dividing the RPP by the total weight lifted in each respective lift.

Statistical Analysis

The variables of interest were total chest, total leg, and total body lift numbers, normalized post RPP (NPRPP), and normalized pre and post exercise rate pressure product difference (NRPPdiff). A one-way ANOVA was used to compare the treatments effect on each of the aforementioned variables. A two-way (gender × treatment) ANOVA was used to test the treatment effect on lift numbers by gender. A two-way (gender × RPP) ANOVA was used to test treatment effect on $NRPP_{diff}$, NRPP in gender. Tukey test was used for the Post Hoc analysis, for any significant differences. Statistical significance was set at alpha level as 0.05. All analyses were conducted by using SAS software (SAS 9.4, SAS Institute Inc., NC, USA).

RESULTS

The total chest, total leg and total body lift numbers for both treatments are depicted in Figure 1. There were no significant differences for treatment effect on chest lift ($p=0.94$), leg lift ($p=0.86$) and whole body lift numbers ($p=0.87$). In addition, there was no significant difference ($p>0.05$) between the number of repetitions (lifts) for both within and between treatment days for each set (i.e. set 1, set 2, and set 3 had a statistically similar number of lifts in all instances).

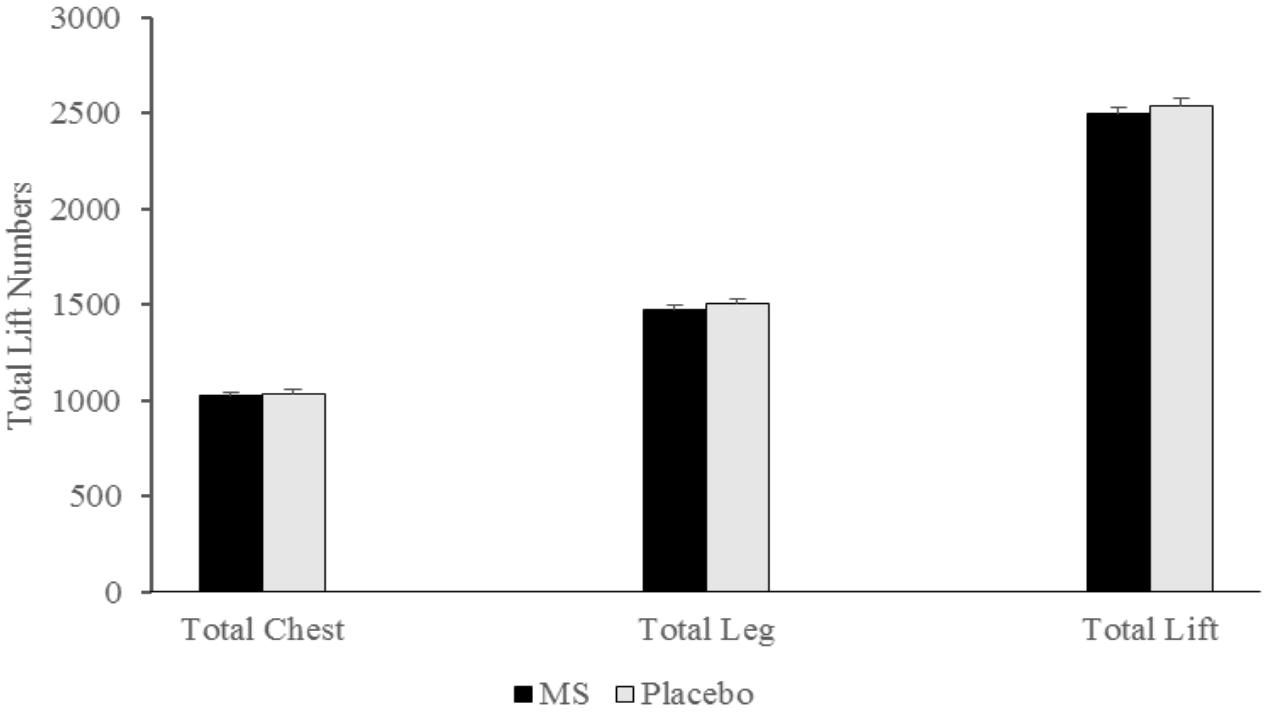

Figure 1. Total Lift Numbers. There was no significant difference between treatments and lift numbers (MS: Muscle Sentry®).

There was no significant difference in treatment effect on gender, for chest lift numbers (p=0.87), leg lift numbers (p=0.95), and whole body lift numbers (p=0.96) (Figure 2).

Finally, there was no significant difference between the treatments on either $NRPP_{diff}$ or NPRPP (p=0.43, 0.87 respectively) (Figure 3). There was, however, a significant difference between gender on NPRPP (F=35.22, p<0.001), independent of treatments. Furthermore, there was a significant difference between gender on $NRPP_{diff}$ (F=7.77, p<0.008) (Figure 4), meaning post RPP increased more in females than that in males.

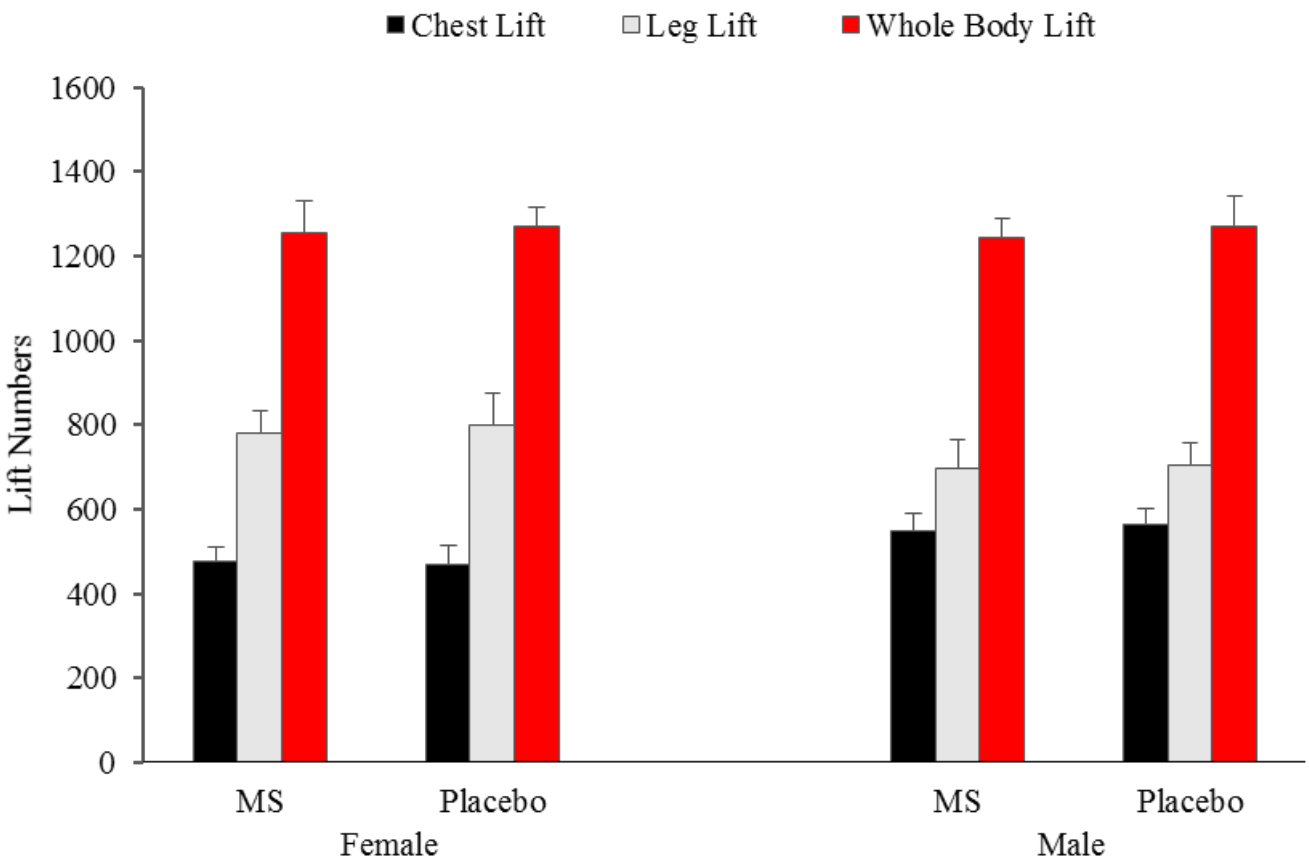

Figure 2. Treatment on different lift numbers for gender. There was no significant difference between treatment effect on lift numbers in genders (MS: Muscle Sentry®.).

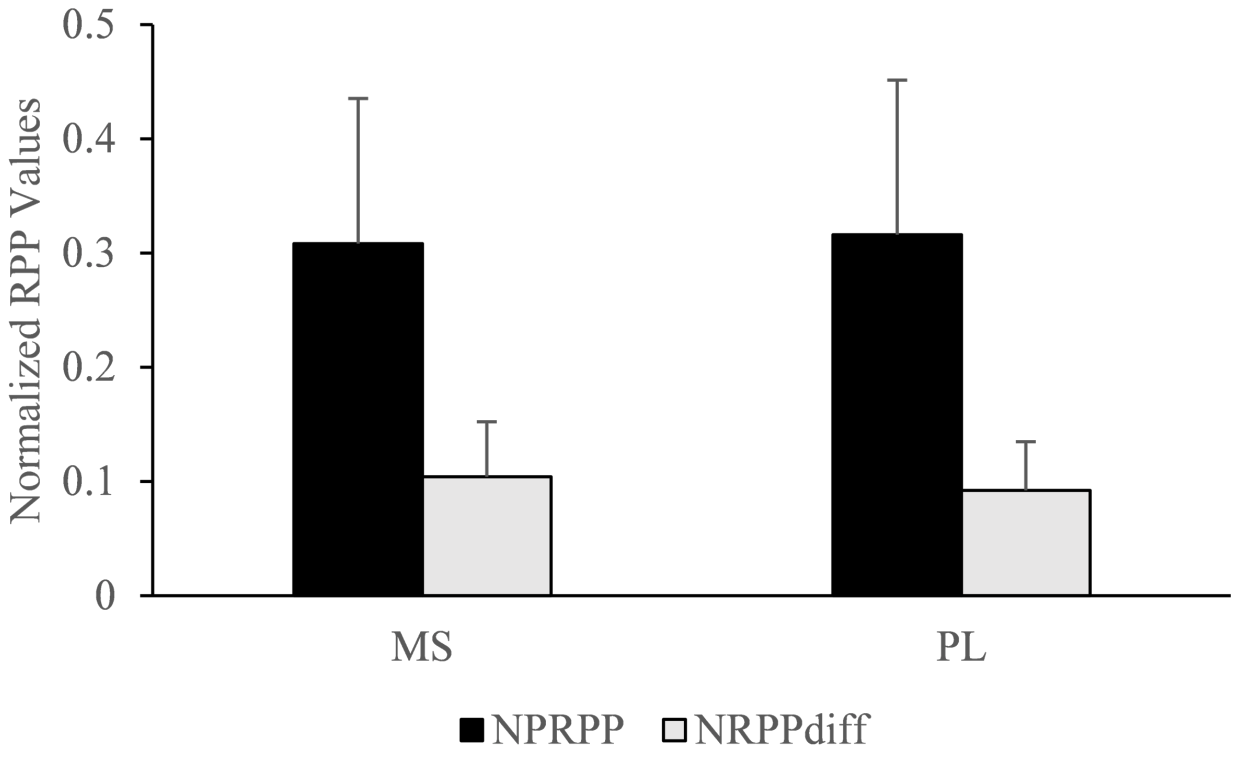

Figure 3. Treatment on NPRPP and $NRPP_{diff}$, there was no significant treatment difference on normal post RPP and normal RPP difference.

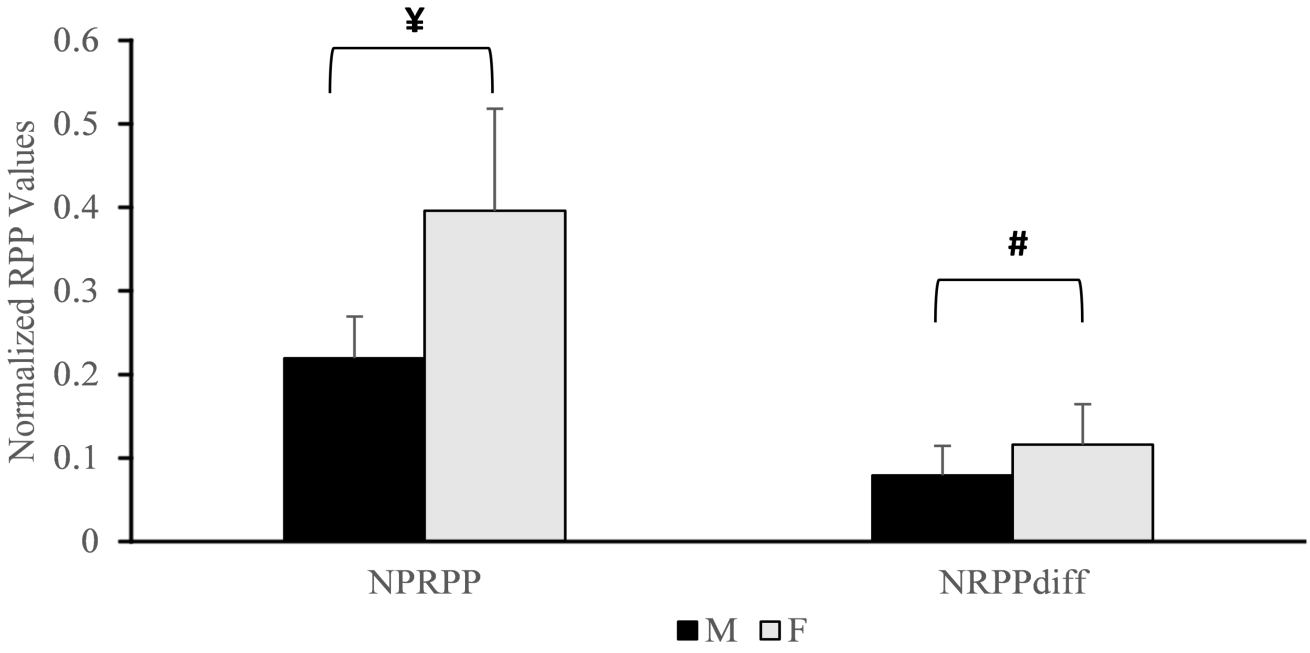

Figure 4. The difference of NPRPP and $NRPP_{diff}$ for Gender. There was significant gender difference in normalized post RPP and normalized RPP (M: male, F: female; ¥, # $P<0.05$).

DISCUSSION

The goal of this study was to determine if ingestion of Muscle Sentry® would increase the amount of lift numbers on repeated high-intensity short duration exercise. The main finding was that Muscle Sentry® did not have any statistically significant effects on the magnitude of high-intensity work performance for an exercise program using chest press and leg press machines. Additionally, Muscle Sentry® did not result in improving myocardial work capacity. Taken together with our lab's previous study (2) of a lack of an increase in muscle stamina with Muscle Sentry®, we can conclude again that Muscle Sentry® does not have any effect on muscle work or myocardial work performance when performing resistance exercise at either a moderate-intensity, long-duration bout, or high-intensity, short-duration bout.

High-intensity, short-duration exercise requires maximal or near-maximal intensity efforts resulting in rapid changes in the intramuscular metabolic profile (12), as of which these changes are accompanied by muscle fatigue (3). Scholars have demonstrated that high-intensity, short-duration exercise induced fatigue can be contributed to an accumulation of potassium ions (K^+) in the interstitium of the muscle cell (25), decreased release/uptake of calcium ions (Ca^{2+}) from/to the sarcoplasmic reticulum (11), depletion of energy substrates, and the accumulation of metabolites within the muscle cell (24). Junior and his colleagues (12) have demonstrated that muscle pH homeostasis is mainly regulated by intracellular, extracellular, and dynamic buffering system during high-intensity, short-duration exercise (12). Lactate supplementation has been suggested to increase extracellular buffering capacity (26), but studies related its effect to exercise performance during high-intensity exercise are controversial. For example, Van Montfoort et al. (26) reported participants' exercise capacity improved by 1.7%, following a run to exhaustion supplemented with a dose of 400 mg·kg^{-1} body mass (BM) of sodium lactate. Furthermore, Morris et al. (15) found that supramaximal multiple bout cycling time to exhaustion and total work increased by 17% when the cyclists were supplemented with 120 mg·kg^{-1} BM calcium lactate. However, Painelli and his colleagues (21) reported that neither 150 mg·kg^{-1} BM nor 300 mg·kg^{-1} BM of calcium lactate improved high- intensity intermittent performance in the form of three upper-body arm-crank bouts. One potential explanation for the inconsistence in findings could be related to the individual exercise protocols (12). Furthermore, the aforementioned investigations administrated similar high-dose, therefore, providing doubt and further controversy on the efficacy of lactate supplementation (12). On the other hand, the dose recommended by Muscle Sentry® and used in current study, was much less than the amount consumed in the aforementioned studies. Therefore, it is reasonable to conclude that Muscle Sentry® would not increase performance of high-intensity, short-duration exercise.

Red cinchona bark is a source of quinine that has been used since the early 1600s to treat malaria (1). However, the therapeutic function of quinine is equivocal. On one side, quinine is a cinchona alkaloid that belongs to the aryl amino alcohol group of drugs (10), with alkaloid being known to stimulate cardiovascular and neurological function resulting in decreased sensations of fatigue during physical stress (23). Thus, quinine has the potential to improve exercise performance. Unfortunately, quinine has a low therapeutic index with adverse effects with its

use being substantial (20). One common side effect is hypoglycaemia (plasma glucose concentration <2.8 mmol/l), and occurs in up to 32% of patients receiving quinine therapy (19). There are scant studies relating the ergogenic effect of quinine on exercise performance, and those results are inconsistence. For example, Gam et al. (5) found that a combination of mouth rinsing and ingestion of a 2-mmol·L^{-1} bitter quinine solution immediately before a maximal 30s cycling sprint improved mean and peak power output. In another study, Gam and colleagues (7) found that motor-evoked potentials (MEPs) were significantly increased by 16% immediately after mouth rinsing and ingestion with the same 2-mmol·L^{-1} quinine solution. They further suggested that the increased MEPs were the cause of the improvement of maximal cycling sprint performance. The conclusions of the above studies were based on the theory that a bitter solution may activate emotional and motor areas of the brain, as well as the autonomic nervous system, all of which might have impacted the maximal sprint performance (6). However, since Muscle Sentry® is an encapsulated supplement, it cannot have a similar ergogenic effect as the supplements used in aforementioned studies. On the other hand, Gam et al. (8) did not find the improvement of 30s cycling sprinting performance, when rinsing mouth only with higher concentration 10-mmol·L^{-1} of quinine solution. Moreover, in contrast to the findings of enhanced MEPs (5, 7), Fung and Holbrook (4) noted that quinine administration showed a decrease in the excitability of the motor end-plate region resulting in a reduced response to repetitive nerve stimulation. Additionally, there are no studies supporting the manufacturer's claim that quinine could be an enabler to improve the performance of other supplements (9). Hence, it is reasonable to conclude that Muscle Sentry® has no significant effects on high-intensity short duration resistance exercise.

The current study did not find any significant effect of Muscle Sentry® on cardiovascular efficiency, which contrasted Peacock et al. (22) who reported a significant mean increase of 3 ml·kg^{-1}·min^{-1} in VO_{2max} following ingestion of Muscle Sentry®. However, VO_{2max} and MVO_2 do not necessarily change in parallel with various exercises (18). Thus, one cannot simply conclude any improvement in VO_{2max} due to ingestion of Muscle Sentry® will increase cardiovascular efficiency. Interestingly, the current study showed women had higher amount of NPRPP and $NRPP_{diff}$ ($p=0.001$, 0.008 respectively) than that of men independent of treatments. This suggests that the women experienced more cardiac stress after the high-intensity short duration resistance exercises. The current finding supports a previous study that the female's response to upper extremities isometric exercise was higher than that of the males (i.e. the women had higher RPPs) (13). However, since the exercise protocol was different in these studies (concentric vs. isometric); it is possible that the mechanisms would also be varied.

Finally, it should be noted that the study was designed to investigate the effect of Muscle Sentry® on muscle stamina of untrained people. Since its effect on trained individuals was not examined, Muscle Sentry® may have a significant different effect upon these two populations. We hypothesized, however, that the benefits of Muscle Sentry® would be better explored by using people who could benefit the most from enhanced stamina, i.e. the untrained or individuals at the lower-end of the stamina continuum. Another limitation of this study was only two exercises were utilized; a number less than normal seen in a regular resistance exercise training (i.e. 5-10 lifts in most cases). Therefore, further studies are needed to examine the effect

of Muscle Sentry® on trained people with multiple sets and more resistance exercises. Ingestion of Muscle Sentry® did not increase exercise performance or heart function during high-intensity short duration resistance exercise.

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