University of BC-Canada: MaxVO2 Improvements and Injury Prevention

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ABSTRACT

Kangoo Jumps are a hard boot with a soft inner liner and flexible ankle cuff, similar appearance to in-line skate boots, with two horizontally opposed leaf springs underneath, as opposed to wheels. Kangoo Jumps are designed to dissipate the impact forces experienced through the ankles, knees, hips and back during running or exercise.
PURPOSE: To investigate whether the use of Kangoo Jumps provides a greater cardiovascular improvement, with fewer injuries, when compared to conventional runners in a walk/run program over a twelve weeks period.
METHODS: Thirteen subjects completed a 12-week, 3 sessions per week training program using normal running shoes (NG) (age: 28.8 ± 4.7; 75.1± 25.2kg), and twelve participants used Kangoo Jumps (KG) (age: 25.4± 5.3; 67.4± 18.0kg), also for a 12 week period. Peak oxygen uptake (VO_2 peak) and ventilatory threshold (Vt) were measured pre and post training program, using a continuous treadmill protocol. All data were analyzed using ANCOVA (α= 0.05), using age as a covariant; injury rates were analyzed with Chi-square 2X2 table (α= 0.05).
RESULTS: VO_2 peak significantly increased in the KG (7.8 ± 3.5 mL/kg/min) compared with NG (1.3 ± 2.8 mL/kg/min) ($p< 0.05$). Vt was not significantly different between groups. NG had a significantly greater incidence of lower leg injuries when compared to KG (χ^2 (1)= 6.7, $p<0.05$). A criterion of 1-week missed training was required for all of the 42.8% lower leg injuries.
CONCLUSION: Training with Kangoo Jumps provides an effective means of improving aerobic capacity, and reducing the rate of injury when compared to training with normal running shoes.

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INTRODUCTION

Running is one of the earliest and simplest types of aerobic activity. The combination of science and technology has lead to the evolution of new forms of running. Kangoo Jumps boots are an example of a new technology that is continuing the evolution of this age-old activity. These boots have a similar appearance to in-line skate boots but differ in that they have a horizontally opposed, two-shell leaf spring system underneath, as opposed to wheels. They are designed to dissipate the impact forces experienced through the ankles, knees, hips and back (Newton et al, 1995). There has not been any literature published which has investigated the use of Kangoo Jumps for improving aerobic capacity.
It is hypothesized that subjects using Kangoo Jumps will have a greater improvement in cardiovascular fitness (VO_2 peak) and ventilatory threshold (Vt), compared with subjects wearing normal running shoes, after completion of a 12-week training program.
Due to the reduced impact of running with use of the Kangoo Jumps, it is also hypothesized that subjects wearing running shoes will have a greater incidence of injury than those wearing Kangoo Jumps. All participants will complete the same walk-run training program as set out by the In Training Sun Run Clinics. The purpose of this study is to determine the efficacy and safety of using Kangoo Jumps as an exercise tool.

METHODOLOGY

Subjects
Twenty-five novice runners volunteered to participate in a 12-week cardiovascular exercise program, which was based on the well-developed Vancouver Sun Run "In Training" clinics. None of the subjects had previously participated in a regimented aerobic program for a minimum of 6 months prior to the study. The Kangoo Jumps group (KG) (n= 13; age: 25.4± 5.3; 67.4± 18.0kg), and the group using conventional running shoes (NG) (n=12; age: 28.8 ± 4.7; 75.1± 25.2kg) completed the same training program, both being led by a certified leader.

Testing
All participants had their peak oxygen uptake (VO_2 peak) measured during week 1 and at the end of week 12. The continuous treadmill protocol started at 4 mph then increased 0.5 mph every minute up to 8 mph, at which point the grade increased 2 % per minute. The subjects stopped the test when they felt they reached their volitional fatigue. All expired gases were collected and analyzed using the Vmax metabolic cart (V6200, SensorMedics Corp, Yorba Linda, CA). Heart rates were measured using Polar Vantage HR monitor (Polar Electro, Finland).

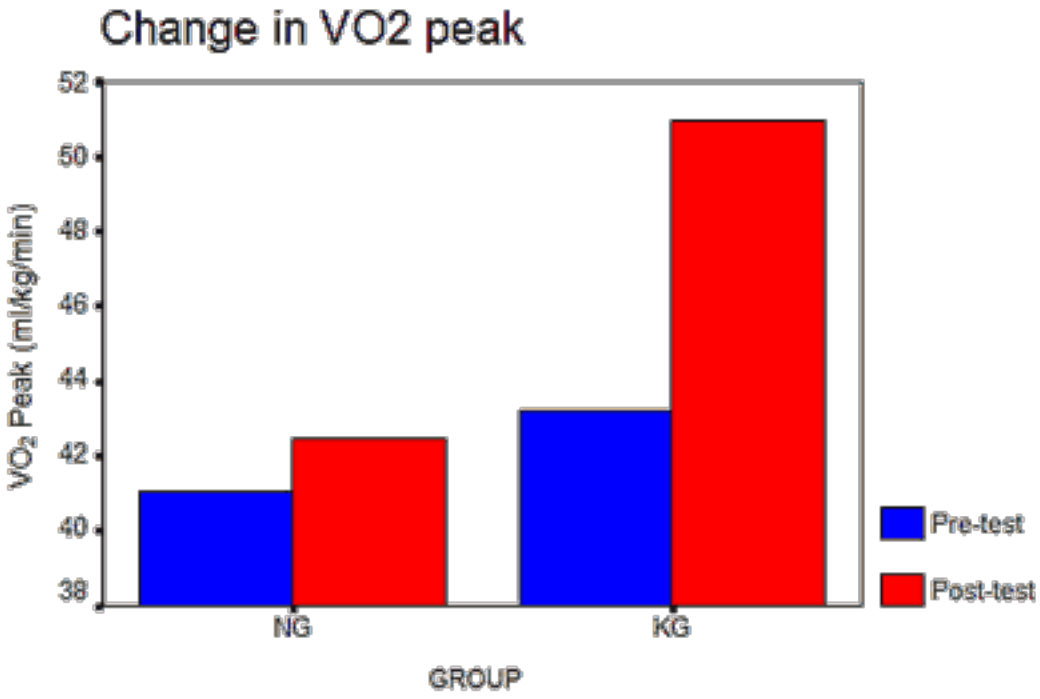
Training
All of the subjects committed to three training sessions per week for a total of 12 weeks; the leader led one session and two other sessions were completed independently. The training program consisted of walk/run intervals, increasing in total duration from 20 to 65 minutes per session. The first session began with a short jog (30 sec) and a 4:30 minute walk, repeated 12 times. The participants' running time and distance gradually increased each week for the entire 12-week program. All subjects kept a training log for the duration of the 12-week program, which provided a monitor of their program adherence and intensity. Recorded in the training log were their heart rate and their rating of perceived exertion (RPE) (Borg, 1975). The data received from the subjects was limited by their honesty and knowledge to self-monitor their performance during their independent sessions.

Statistical Analysis
The data from the treadmill tests were analysed using the SPSS software package. Analysis of covariance was used to determine if there was a significant change in VO2 peak over the span of the training program, co-varying age. A two-way mixed ANCOVA was used to analyse the ventilatory threshold data. X2 2X2 contingency tables were used to determine frequency of injuries between the two groups. These data are reported as mean standard error analyzed with significance set at $p<0.05$, unless otherwise indicated.

RESULTS

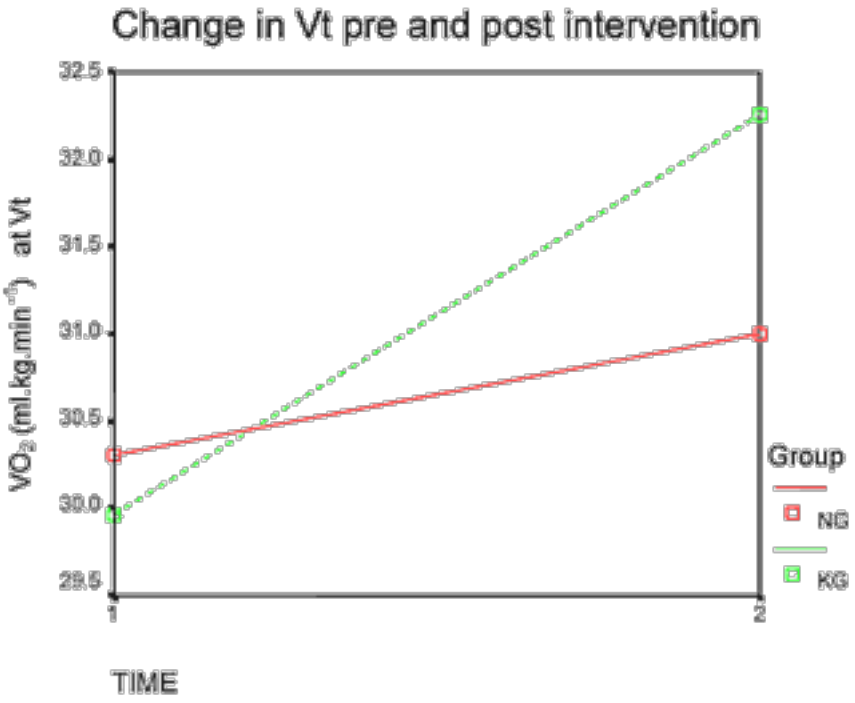
Subjects
On average, the age of the volunteer, novice subjects were not significantly different between the two groups: $t(23) = 1.71$, $p> 0.05$. However, to ensure age had no effect on the results, it was used as a covariant with ANCOVA. The mean weight change over the span of the training program was not significant, NG 1.08 kg 0.585, KG 0.79kg0.594 between the groups ($p>0.05$).

MaxVO2 improvement
The mean pre-intervention VO_2 peak was not significantly different between groups (NG 41.06 1.22 ml kg min^{-1} vs. KG 43.22 2.14 ml kg min^{-1}). However, the mean (SE) KG VO_2 peak significantly increased (+7.8 0.97 ml^{-1} kg^{-1} min^{-1}) compared with NG (+1.3 0.93 ml^{-1} kg^{-1} min^{-1}) ($p< 0.05$) after completion of the training program. Figures 1 and 2 graphically represent the change in VO_2 peak over the training program for the two groups.



Ventilatory Threshold (Vt)

The thresholds were calculated using the excess CO_2 ($ExCO_2$) elimination curve (Frangiolas & Rhodes 1996) and determined by two external reviewers to identify the percent of VO_2 peak where CO_2 demonstrated a sudden and sustained increase (Vt). Age correlated with pre-intervention Vt (r=0.40, p=0.046), and was entered as a covariate into a 2-way mixed ANCOVA. Both groups saw an increase in VO_2 at Vt, with KG increasing to a larger degree than NG (7 .9%10.47compared with 2.59% 6.41 respectively, t (17.97)=1.51, p=0.15). ANCOVA showed no main effects of time (F (1,22)=0.28, p=0.60), or group (F (1,22)=0.07, p=0.79) or an interaction of time by group (F (1,22)=2.61, p=0.12). Fig 3 shows the VO_2 ($ml.kg.min^{-1}$) at which Vt was reached. Figure 3 shows the mean improvement of VO_2 at Vt over time by group.

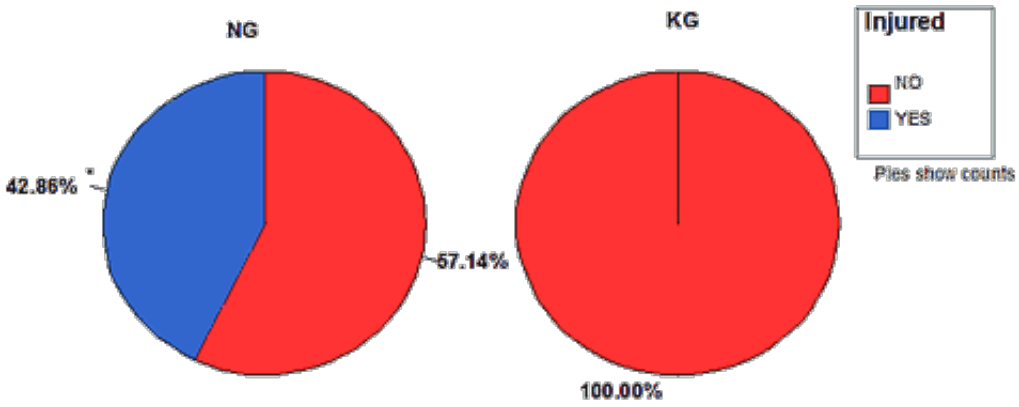


Injuries
NG had a significantly greater incidence of lower leg injuries when compared to KG (χ^2 (1)= 6.7, $p<0.05$). Table 1 shown the tabulation of injury rate of the two groups.
A subject was classified as injured if they fulfilled at least one of the criteria below (Taunton, 2002; Johnston 2002):

a. Pain or symptoms during or immediately after a run;
b. Had pain or symptoms within approximate time span of start of running program;
c. Injury was felt to be related to running;
d. Injury was significant enough to force them to stop running or significantly reduce their running mileage and seek medical attention;
e. Required to stop running for min of 1 week.

According to the chi-squared analysis (see Table 1), 42.8% of the subjects in NG were forced to reduce or end their training due to lower leg injuries, whereas no injuries caused interruption to subjects in KG. Figure 4 graphically represents the breakdown of injured subjects per group.

Figure 4- Chart of % of injuries between groups
***p<0.05**



CONCLUSIONS

Max VO_2 Improvement
These data have shown that KG had a statistically significant improvement in VO_2 peak compared to NG. No research has been conducted to investigate the effectiveness of the In-Training running program; therefore there was no literature available to determine the extent of VO_2 peak change. The American College of Sports Medicine (1990) stated that a minimum of 50% of VO_2 peak must be maintained in order to gain cardiovascular benefits. There is usually an improvement in VO_2 peak of 5-10% after a 12-week training program. However, NG only had a 3.7% improvement in VO_2 peak, whereas KG improved 18.3%. From these results, we may presume that NG did not complete their training sessions at an intensity level near 50% of their VO_2 peak. All of the subjects had been properly educated to record their RPE and Heart Rate in order to ensure maintenance of a minimum level of intensity. Although, it appears that NG lacked the ability to self-monitor their exertion level during their sessions.
An additional explanation for the difference in post training VO_2 peak is perhaps that the Kangoo Jumps mechanism required more energy to propel the body forward, due to the requirement to compress the tension band, whereas a conventional runner does not demand the same energy. Therefore, when comparing the two types of footwear, there is more energy expended when using Kangoo Jumps; thus requiring greater oxygen consumption, with a greater demand on the cardiovascular system in the body. Figure 1 and 2 provide a visual diagram of the extent of aerobic capacity that increased over the training period (all figures in ml • kg • min^{-1}).

Ventilatory Threshold (Vt)
Ventilatory threshold is thought to be a measure of the body's inability to maintain exercise using aerobic

metabolism, which therefore an increased utilisation of the anaerobic system. As a result, an increase in VO_2 at Vt would indicate a greater efficiency of the aerobic system of the subject.
Both groups did show an increase inVO_2 at Vt post intervention, with the KG group (2.28 $ml.kg.min^{-1}$ increase) demonstrating a greater increase than the NG group (0.71 $ml.kg.min^{-1}$ increase). However, results of a two way mixed ANCOVA show no main effect for time or group, or an interaction effect $p>0.05$.
The lack of a significant change in VO_2 at Vt between and within groups may in part be due to the relatively large standard deviation. A larger sample size may have resulted in a statistically significant change, as the few subjects with very large changes in VO_2 at Vt may be distorting the data.
Despite the increases in VO_2 peak, the intensity of the training may not have been sufficiently high to result in an increase in VO_2 at Vt. The intensity of the exercise needs to be high enough to recruit the anaerobic metabolism and so needs to be near the lactate or ventilatory threshold in sedentary subjects. The training level needs to be slightly above the lactate or ventilatory threshold in trained subjects, so the amount of change may have been dependant on initial fitness level.

Injuries
Of the NG subjects, 42.8% suffered lower leg injuries; compared with no injuries in the KG, refer to Table 1, and graphically represented in Figure 4. None of the subjects had previous injuries directly related to an aerobic training program. The injuries that plagued the subjects included:
1. Iliotibial Band Friction Syndrome
2. Shin Splints
3. Ankle sprain
4. Plantar Fascitis

Of the injuries, which occurred during the training program, 3 were unable to complete their goal of running the Vancouver Sun Run; in addition, 1 subject was not able to complete the post treadmill test due to severe injury.
The training program was developed in a manor to minimize the number of injuries incurred from running, if the program is followed carefully. The subjects who were injured during the study may have not followed the program to detail, which may have made them more prone to a lower leg injury. There are also other extrinsic factors that may have caused circumstances for injuries such as worn out shoes, muscular imbalances, or improper biomechanics.
The KG group suffered minor problems associated with the Kangoo Jumps boots. When introducing the Kangoo Jumps to a new user it is recommended by the manufacturer to wear long socks that will protect your skin, above the top of the boot, from abrasion. They also comment that there may be an adjustment period for the arches of your feet to familiarize with the new sensation of using the Kangoo Jumps.

In this study subjects were spending from 30 minutes to 65 minutes in the boots, and there were some minor problems that the subjects experienced. These problems required a decrease in training for maximum 1 session; however, had the problems been identified earlier subjects would not have missed any training. One of the problems included bruising and swelling around the lateral and medial maleolus. This was remedied by wearing a gel sock to provide more padding to subjects with bony ankles. If the problem persisted with the subject, it was recommended to cut out a large foam donut and tape in into place around the maleolus. Kangoo Jumps are currently developing a more improved boot that may reduce the bruising and swelling by using a softer shell boot.
Blisters are a problem with new running shoes and they are also a problem with the Kangoo Jumps particularly with less breathability of the boots. If the blisters are left alone, they may worsen. The best option to resolve the blisters is to purchase long wicking socks that will help remove the moisture away from the skin on your foot, making it less prone to abrasion. Any lubricating cream may also help to reduce the friction when the subject is getting used to the boots.
Kangoo Jumps are able to fit most body types, however people with larger calves may not be able to get a snug fit around the foot and ankle with the boot. If the boot does not fit properly the subject will not be able to maintain long periods of walking or running in the boots, as problems will arise, such as those mentioned above.

Training
The program used for the aerobic training program was developed by sports medicine physicians to safely introduce participants of all levels to the sport of running in preparation for a popular 10 Km road race in

Vancouver, BC. The particular level chosen for this study begins with a short jog, followed by a lengthy walk, for a total of 5:00 minutes. As the program progresses week, the run time increases by 30 seconds, and gradually increases the length of the running time once it surpasses 5:00 minutes. In order to gain full benefit from this program it is necessary to maintain movement during the walk segments of each session. While wearing Kangoo Jumps walking is a little more difficult than wearing running shoes, therefore, the walk is more of a walk with a bounce; which may require more energy than using running shoes which may add to the amount of work performed per session. This may be another reason for an improved VO_2 peak in the post-test.

SUMMARY

There is no literature published that investigates the use of Kangoo Jumps as an effective exercise tool. This study has concluded that Kangoo Jumps, when compared with a group wearing normal running shoes, can have a greater effect on cardiovascular improvement, while reducing the risk of injuries. Kangoo Jumps could also be an effective tool for intervention in rehabilitative circumstances for lower leg injuries.
However, more research is needed to investigate the use of Kangoo Jumps for rehabilitation purposes. There is also a need for further research into the effectiveness of the In Training running program with a larger number of subjects.

Quelle: www.kangoojumps.com