MAXIMAL IMPACT AND PROPULSION FORCES DURING JUMPING AND EXPLOSIVE LIFTING EXERCISES

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Eight male subjects (Ss) performed standing vertical jumps (VJ), drop jumps (DJ) from 42 and 63 cm and 75-90% 1 RM power cleans (PC) on a force plate. Maximal impact and propulsion ground reaction forces (GRF) were compared during the thrust and landing/catch phases of these exercises. Concerns have been raised by some coaches that explosive lifts create force levels dangerous to the musculoskeletal system (MS). Results showed similar maximal thrust GRF values relative to body weight (BWT) for all Ss in PC and DJ (3.35 ± 0.36 to 3.49 ± 0.73 x BWT), but lower thrust values for the VJ (2.81 ± 0.37 x BWT). However, maximal relative GRF during

landing/catch phases were higher for all Ss in VJ and DJ (3.68 ± 1.02 to 4.54 ± 1.35 x BWT) and lower in PC (2.67 ± 0.56 x BWT) compared to thrust GRFs. Realizing that landings from jumps during competition (eg., basketball, volleyball) are often single-legged or off balance, these data indicate that use of explosive lifts in training are less stressful to the MS than normally occurring landings from jumps.

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INTRODUCTION

Use of Olympic style weightlifting and plyometric exercise has become a popular and controversial method of training. The controversy stems from some authors who have made claims that explosive lifting exercises generate force levels that are dangerous to the musculoskeletal system. For example, Matt Brzycki writes in Athletic Bussiness ; "Athletes should not be allowed to explode with a weight since this exposes their joints and connective tissue to enormous forces, which may cause immediate injury or predisposition to future injuries. Potentially dangerous exercises or activities that place excessive strain on the musculoskeletal system such as barbell squats, power cleans, snatches and plyometrics should be avoided." Mr. Brzycki is also quoted from Scholastic Coach stating..."Coaches who encourage their athletes to 'explode' with a weight are begging for musculoskeletal suicide". E. Darden from his book Conditioning for Football describes explosive weightlifting as "probably the most dangerous style of training, a style of training that will do very little except produce injury." (see attached list for more references of this nature)

PURPOSE

The purpose of this study was to measure ground reaction forces for power cleans and various jumps and then to compare the magnitude of peak vertical ground reaction force (VGRF) between activities.

METHOD

Subjects: Eight male athletes from various sports were the subjects in the study. All participants demonstrated a high level of skill in performing the power clean.

Equipment: The equipment needed for the study included: a barbell, a Vertec vertical jump measuring device, a 42 and a 63cm tall jumping box and a Kistler force platform.

Procedure: The subjects performed five different activities on the force plate; a maximum standing vertical jump, which included landing back on the force plate, an 80 and a 90% of 1RM power clean and two drop jumps, one from 42cm and one from 63cm. Ground reaction forces were measured for the duration of these activities including the propulsion and impact phases.

The following are definitions for the "IMPACT" and "PROPULSION" phases:

VERTICAL JUMP propulsion = From the point of the smallest knee angle during the counter movement to the time of take off.

impact = Upon landing back on the force

plate after the jump.

POWER CLEANS	propulsion =	The explosion phase or second pull.
	impact =	Catching or "racking" of the barbell on the shoulders.
DROP JUMPS	propulsion =	The same as the vertical jump.
	impact =	The initial landing prior to the propulsion phase.

The subjects were instructed to perform the power cleans as "quickly" and "explosively" as possible and to jump as high as possible. The subjects were given three trials for each activity. Only the data from the highest jumps were analyzed.

RESULTS

The results from a single subject and the mean for all eight subjects are presented here.

Graph one represents a typical subject and shows the change in propulsion VGRF over time. It is interesting to note that the shape and magnitude of the curves are very similar for both drop jumps and both power cleans.

Graph two is a bar graph for the same subject showing the peak VGRF during the propulsion phase. All of the bar graphs display the peak VGRF magnitudes relative to body weight (BWT = 1). Note that the highest values were reached during the drop jumps and lowest for the vertical jump.

In graph three the mean peak propulsion VGRF's and standard deviations are given. The values for the power cleans and the drop jumps are nearly identical and considerably less for the vertical jump.

Graph four represents the impact VGRF over time for the single subject. The impact VGRF is higher during the jumps and lower during the power cleans.

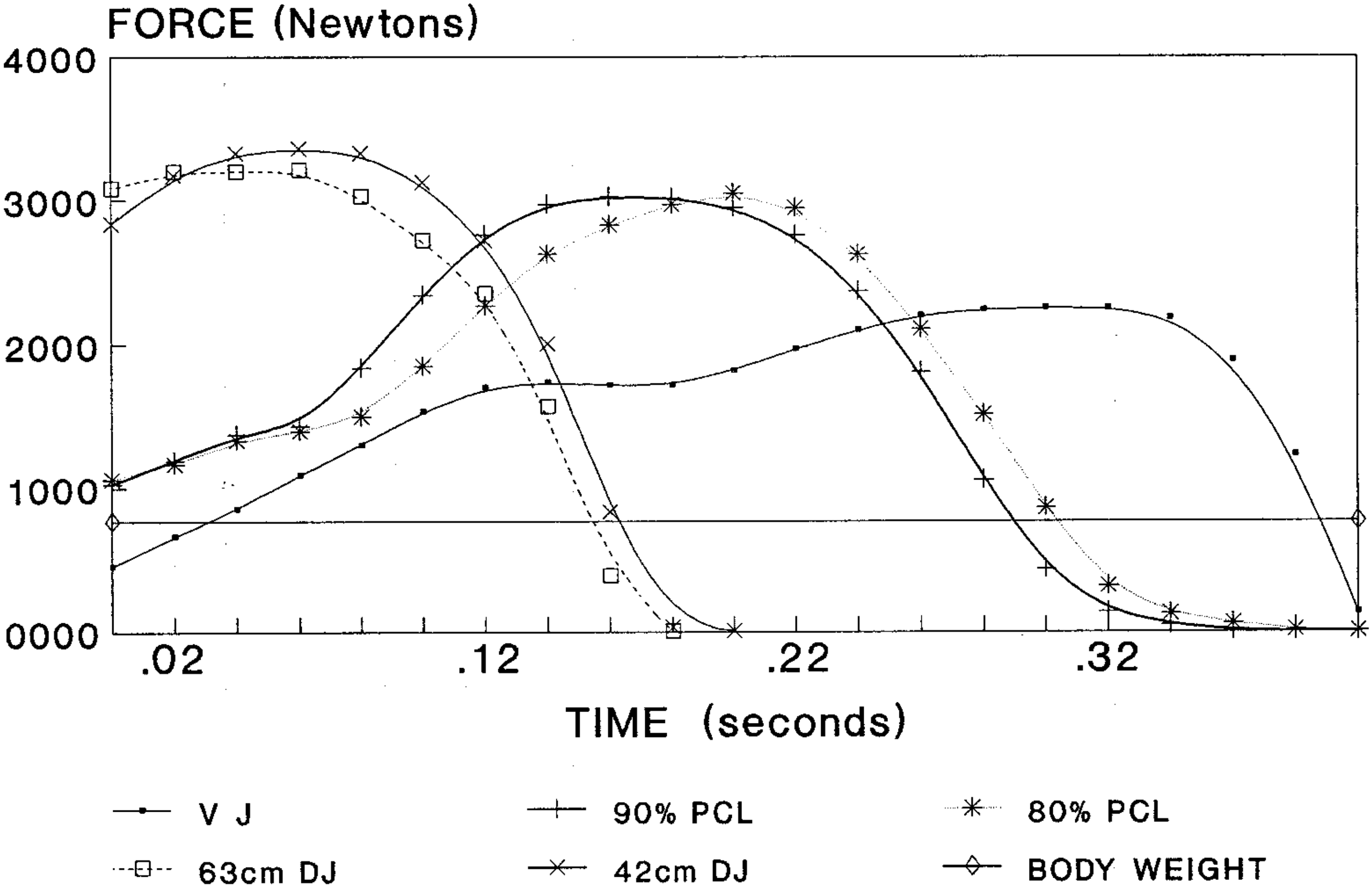
Graph five gives peak impact VGRF values for the single subject where the magnitudes can be compared.

The same trend can be seen in graph six which represents the average peak impact VGRF.

DISCUSSION AND PRACTICAL APPLICATION

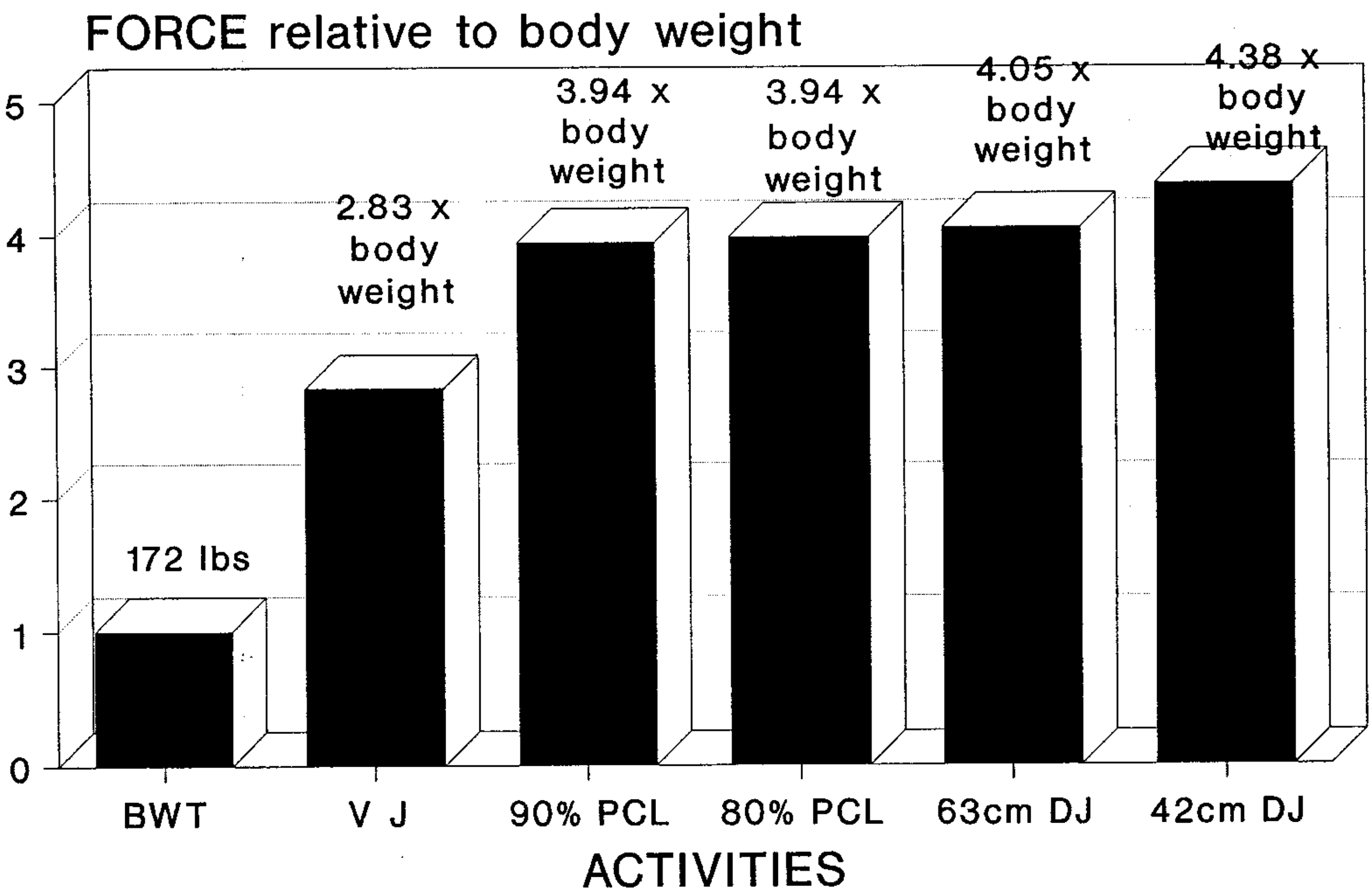
The results of this study indicate that performing power cleans with proper technique does not stress the lower extremity any more than typical jumping movements. It should also be remembered that all of the jumps in this study were performed under controlled laboratory conditions, and that jumps, and landings from jumps performed in competition are often unbalanced and on one foot. Strength coaches can present this information to coaches and athletes who are concerned with the safety of performing explosive lifting exercises.

PROPULSION GROUND REACTION FORCES

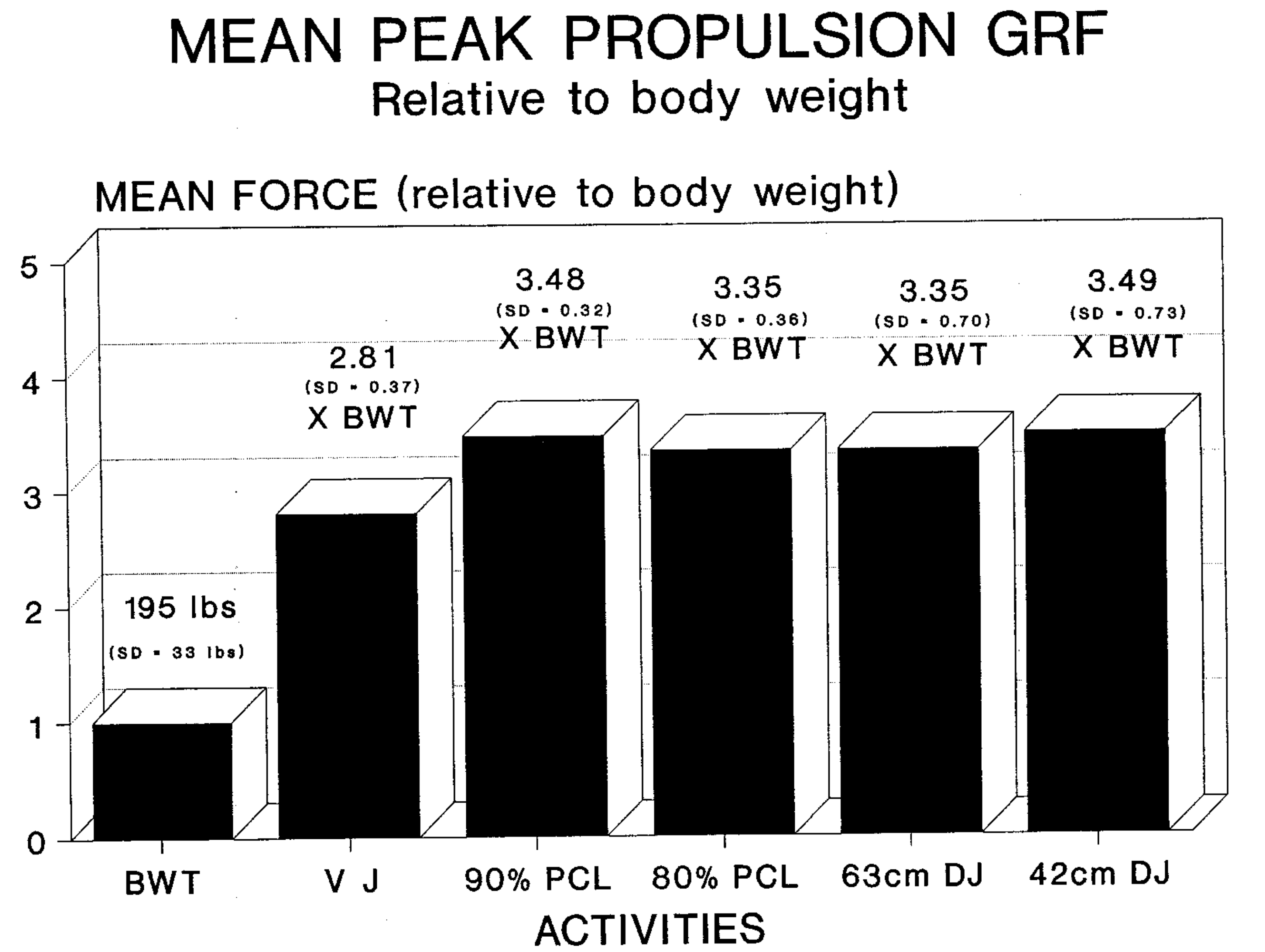


GRAPH # 1

PEAK PROPULSION GROUND REACTION FORCES
Relative to body weight

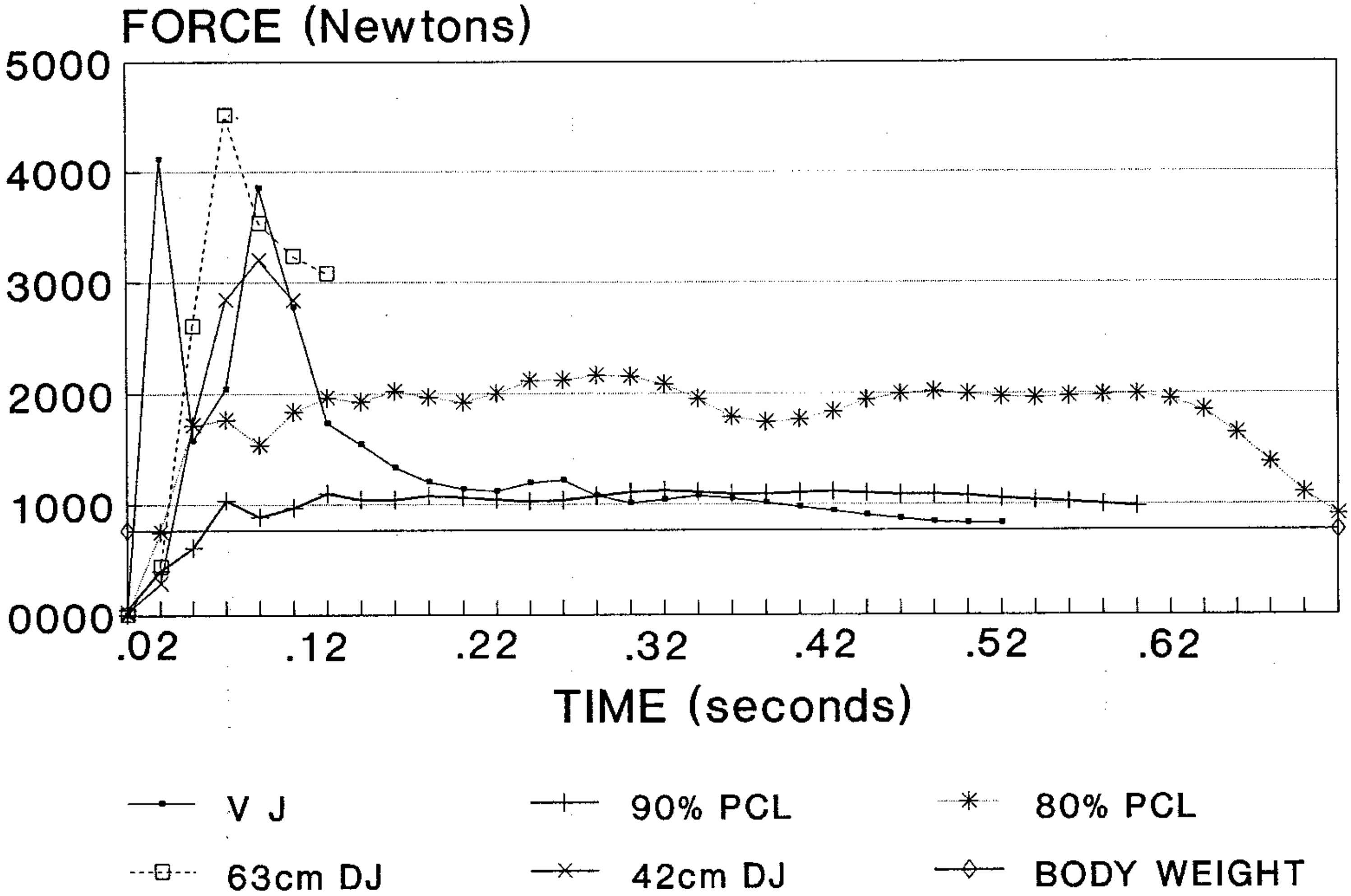


GRAPH # 2


MEAN PEAK PROPULSION GRF
Relative to body weight
MEAN FORCE (relative to body weight)
5
4
3
2
1
0
195 lbs
(SD = 33 lbs)
2.81
(SD = 0.37)
X BWT
3.48
(SD = 0.32)
X BWT
3.35
(SD = 0.36)
X BWT
3.35
(SD = 0.70)
X BWT
3.49
(SD = 0.73)
X BWT
BWT
V J
90% PCL
80% PCL
63cm DJ
42cm DJ
ACTIVITIES

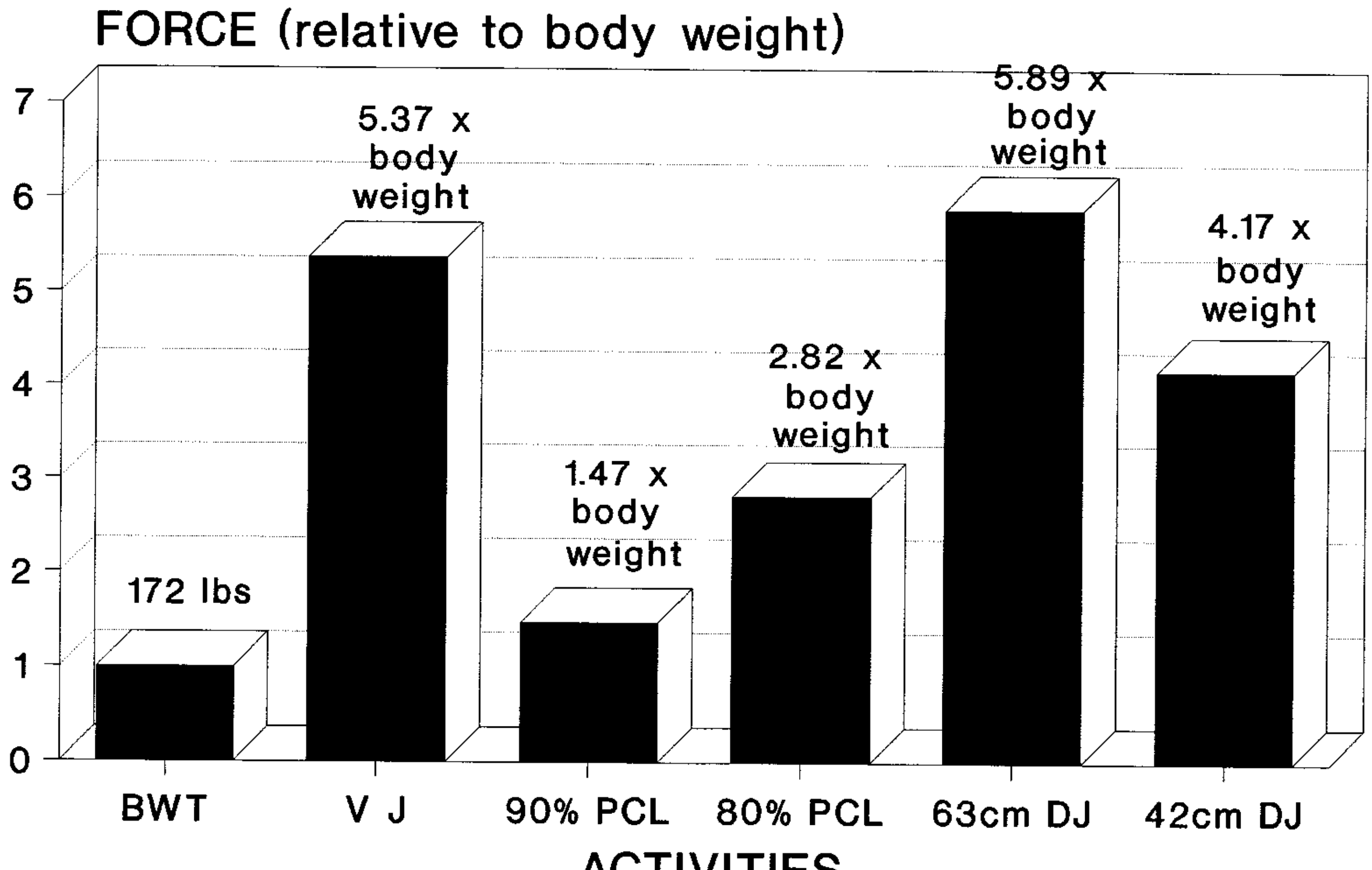
GRAPH # 3

IMPACT GROUND REACTION FORCES



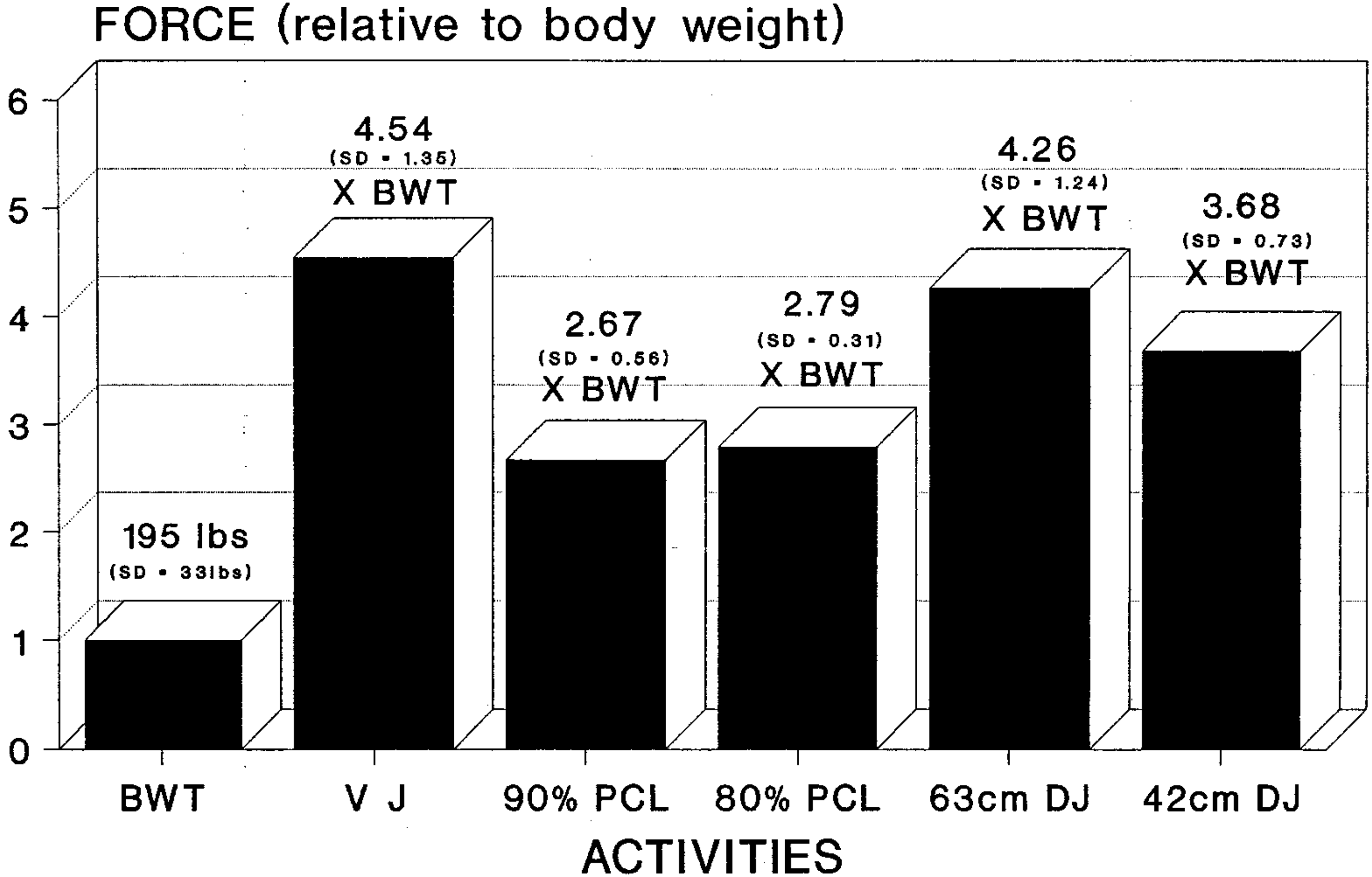
GRAPH # 4

PEAK IMPACT GROUND REACTION FORCE
Relative to body weight



GRAPH # 5

MEAN PEAK IMPACT GRF
relative to body weight



GRAPH # 6