

1992

Relationship between sleep and exercise as demonstrated by powerlifters

Rashmita S. Mistry
San Jose State University

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San Jose State University, 1992

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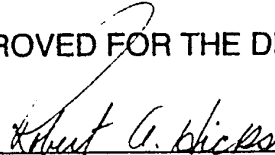
RELATIONSHIP BETWEEN SLEEP AND EXERCISE AS
DEMONSTRATED BY POWERLIFTERS

A Thesis
Presented to
The Faculty of the Department of Psychology
San Jose State University


In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
Rashmita S. Mistry
December, 1992

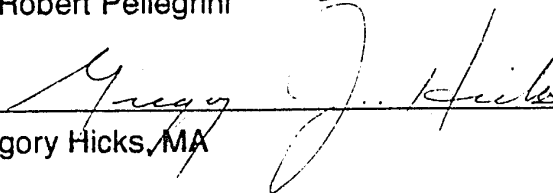
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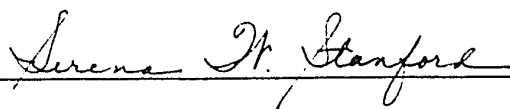


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ABSTRACT

RELATIONSHIP BETWEEN SLEEP AND EXERCISE AS DEMONSTRATED BY POWER LIFTERS

by Rashmita Mistry

Previous research by Martinez and Hicks (1986) revealed that spontaneous sleep reductions of between one to three hours had positive effects on strength. This study sought to replicate and expand on the Martinez and Hicks study. To do this, 14 competitive, drug-free power lifters were asked to maintain a daily sleep log and a weight-lift diary for six months.

A one way analysis of variance computed on the weight lift data across eight hourly deviations of the sleep data was found to be non-significant. The results of the present study failed to replicate the original findings of Martinez and Hicks (1986). Plausible explanations for the results of the study include the small sample size, the duration of the study, and the measurement timing of the subjects.

ACKNOWLEDGMENTS

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Relationship Between Sleep and Exercise
as Demonstrated by Power Lifters

Rashmita S. Mistry

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Running Head: SLEEP AND EXERCISE AS
DEMONSTRATED BY POWERLIFTERS

Footnotes

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Abstract

Previous research by Martinez and Hicks (1986) revealed that spontaneous sleep reductions of between one to three hours had positive effects on strength. This study sought to replicate and expand on the Martinez and Hicks study. To do this, 14 competitive, drug-free power lifters were asked to maintain a daily sleep log and a weight-lift diary for six months. A one way analysis of variance computed on the weight lift data across eight hourly deviations of the sleep data was found to be non-significant. The results of the present study failed to replicate the original findings of Martinez and Hicks (1986). Plausible explanations for the results of the study include the small sample size, the duration of the study, and the measurement timing of the subjects.

Relationship Between Sleep and Exercise as Demonstrated
by Power Lifters

Research in the area of REM sleep and its effects on different bodily functions suggests that REM sleep increases energy output (e.g., see Puentes, Bautista, Mistry, Phillips & Hicks, 1992). In this context a limited number of studies have examined the relationship between REM sleep and energy output, through the operationalization of output as exercise performance.

For example, working under the premise that the duration of REM sleep is reduced after exercise, Bunnell, Bevier, and Horvath (1984) compared the effects of sleep interruption in instances where REM sleep interruption was superseded by a period of physical activity, and instances in which the interruption was followed by no physical activity. Their results lent support for the earlier findings in that induced exercise following a forced interruption in REM sleep produced the effect of suppressing the duration of REM sleep superseding the interruption. Bunnell and his colleagues attributed the cause of the observed decrease in REM sleep to the enhanced metabolic rate resulting from the induced exercise following the sleep interruption.

In a related study, Angus, Heslegrave, and Myles (1985) investigated the effects of physical exercise and sleep deprivation on mood and cognitive performance. They deprived subjects for a total of 60 hours across two occasions. During each session half of the subjects participated in a total of 20 hours of exercise across the total sleep deprivation period. The engaging exercise consisted of walking a treadmill at 25-30% maximum aerobic capacity for one out of every three hours. The remaining subjects were kept mentally occupied but were not involved in any form of physical activity. As a result of these manipulations they observed that moderate and regular exercise did not modify sleep deprivation effects significantly and that the subjective reports of the ability to perform cognitive tasks did not significantly differ among the exercise and the no exercise groups. In a subsequent study, Symons, VanHelder and Myles (1988) examined the effects of 60 hours of sleep deprivation upon physical performance and physiological response to exercise. Their results suggested that sleep loss of up to 60 hours also did not impair the capability for physical work.

An examination of the research in the area of the effects of REM sleep on exercise demonstrates a reliance on endurance exercise measures, such as the treadmill, as a measure of aerobic capacity. Another line of research in the area of the physiological effects of REM sleep has deviated from the traditional measure of exercise and has sought to demonstrate a possible link between sleep and a measure of energy output, defined as strength (Martinez & Hicks, 1986). Martinez and Hicks investigated the relationship between sleep and energy output by assessing the association between the sleep cycles and weight lift logs of four competitive weight lifters for a period of three months. Their results revealed that spontaneous sleep reductions of one to three hours had a positive effect (4% mean increase in total weight lifted) on the strength of the weight lifters, as compared with nights where sleep was not reduced. Furthermore, Tinder, Paxton, Montgomery and Fraser (1985) reported that the type of physical training that an athlete engages in affects the nature and duration of sleep. They reported that in comparison to aerobically trained endurance runners, power lifters slept for a shorter amount of time. The results of Martinez and Hicks (1986) therefore, can be viewed as providing support for the results of Tinder, Paxton, Montgomery and Fraser. It appears as though power lifters may in fact benefit from the slight sleep reductions in their overall sleep cycles.

Although interest in investigating the relationship between sleep and the energy output of athletes appears to have waned during the late 1980's, the objective of the present study was an attempt to replicate and verify the results obtained by Martinez and Hicks (1986) and, indirectly, the results obtained by Tinder and his colleagues (1985). Specifically, this study sought to replicate the Martinez and Hicks study while incorporating a larger sample of both male and female power lifters, and tracking their sleep and weight lift cycles across a longer time frame of six months.

Power lifters were elected as participants due to the nature of the sport. Within the overall scope of sports characterized as "weight lifting," power lifters represent one category of weight class above that of body-builders. The focus for the majority of body-builders is on improving the outward appearance of one's physique. This is typically achieved by lifting lesser amounts of weight across a greater number of repetitions. In direct contrast the focus for the

majority of power lifters is on their ability to lift an increasing amount of weight, in pounds. The emphasis on the actual amount of weight lifted allows power lifters to channel more energy into being able to lift more weight across a fewer number of repetitions.

Because of the greater emphasis placed on actual weight lifted, the utilization of power lifters as a measure of energy output, or as an index of strength, was deemed appropriate.

Method

Subjects

The subjects were 16 (i.e., 11 male and 5 female) experienced, competitive power lifters were recruited and volunteered to participate in the study. These subjects were recruited from a 1989 listing of membership to the American Drug Free Power Lifting Association (ADFPA). The ADFPA was utilized as means of indirectly controlling for and screening out the use of substances which may have altered sleeping patterns.

As a result of physical injuries incurred during the course of the study, 2 power lifters (i.e., 1 male and 1 female) were unable to continue; thus, 14 subjects completed the study.

Measures

Weight Lift and Sleep Diary

A two-part diary was drawn up for this study. The forms used for the lift log portion of the diary were the exact forms used by the power lifters to log their lifts. As such, the exact format of the logs varied across subjects.

The daily sleep log portion of the diary was drawn up by the researcher and was distributed to the participants, with instructions that they be submitted to the researcher as an attachment to their daily lift logs. The format of the sleep log was standardized and consisted of recording the amount of sleep the participant had had that particular day; the time that he/she went to sleep (the prior night); the time he/she woke up; and any naps taken during the day. Additionally, participants were asked to log the approximate lapse time between when they went to bed and the time that they actually fell asleep. Finally, all subjects were instructed to list the start and stop time of their work out during the day. A copy of the complete diary form is included in Appendix A. The lift log

included is for demonstration purposes only. As mentioned above, the precise format was necessarily unique to each participant and thus varied between subjects.

Procedures

At the time of recruitment, all potential participants were given a verbal account of the degree of commitment required of all participants involved in the study. All recruits were informed of the longitudinal nature of the study and the necessity to disclose what are often considered personal and sacred weight-lift logs. The recruiting process involved one of two methods. The first of the two methods involved approaching power lifters personally at the gym or health club where they worked out. Permission from the manager of the gym or health club was obtained prior to approaching any individuals. In one instance, the manager, working upon the information given during a telephone conversation, recruited a number of individuals who used his gym and arranged for an informal meeting between the individuals and the researcher.

The second means of obtaining recruits for the study involved telephone calls made to members listed in a 1989 listing of ADFPA. In both cases, individuals were provided with a verbal introduction as to the basic premise of the study, and screened for both current membership to the ADFPA and active participation in either amateur or professional competition.

Verbal consent to participate was followed up by a request to read and sign a consent form authorizing the use of the lift logs during the duration of the study. A copy of the consent form is included in Appendix B. Upon receipt of the signed consent form all subjects were supplied with a copy of the Subject Protocol. The Subject Protocol, which is included in Appendix C, was used to ensure procedural uniformity across participants. Personal Identification numbers selected from a table of random numbers were used as a tracking device and did not reflect any distinguishing characteristics of the participants.

The Subject Protocol was one of the components included in an introductory package mailed to all participants. Also included in the package was a copy of a letter written and signed by Joseph J. Randazzo, who was the California State Chairman of ADFPA at the time. The letter was included as a means of encouraging commitment from the participants, as well as lending "face validity" to the study. A copy of this letter is included in Appendix D.

The sleep log portion of the diaries were distributed to each subject on a weekly basis, and participants were instructed to mail in both the sleep and the weight lift logs on a weekly basis. Remainder notices were mailed for instances where logs were not received. These procedures were carried out for the entire length of the study. Periodically, the data were inspected for accuracy and completeness.

Results

The generally followed guidelines for the transformation of the data used were those established by Hicks and Garcia (1986). In a study designed to assess the relationship between sleep and daily levels of stress, Hicks and Garcia initially transformed the reported total sleep duration data as well as the daily stress level data, for each subject, into a set of standard scores. This procedure was carried out so as to ensure that the data could be assessed and analyzed across subjects while controlling and accounting for individual differences amongst them.

The obtained data set was then inspected and deviations in stress level (± 2 standard deviations) were identified and extracted. These data points then served as the basis for the statistical analysis performed.

For the purposes of the present study, daily total sleep duration data, including nap times, for each subject were converted into a set of standard scores. The same procedure was also performed on the weight lift portion of the data. An a priori decision was made to analyze only the "bench-press" and "squat" exercise portion of the weight lift data. This decision was based on a review of the weight lift logs, which revealed that only the bench-press and squat exercises were performed uniformly across all subjects.

After both the sleep and weight lift data had been transformed into standard scores, the sleep data set was inspected and divided into eight separate time intervals, each representing an hour's deviation from the mean. The intervals spanned across one, two, and three+ hourly deviations around the mean.

Within each time interval the corresponding weight lift data across all fourteen subjects were tallied. Table 1 provides a summary of the

standardized means and standard deviations for the weight lift data across the eight sleep deviation intervals.

Utilizing the eight sleep intervals a one way analysis of variance was calculated for the data summarized in Table 1 and the results of this analysis are summarized in Table 2. As is evident in Table 2, the effect of deviations in sleep upon strength was not significant, $F(7, 631) = 0.76$, ns. To further elaborate these data, a series of five post hoc comparisons employing individual t tests were performed to identify the existence of any simple effects among the eight intervals. The results of these analyses are presented in Table 3. As can be seen by inspecting this table, none of these was significant. Thus, it is clear that for these subjects, spontaneous fluctuations in sleep had no effect on strength.

Discussion

The primary objective of the present study was to replicate an earlier finding by Martinez and Hicks (1986) using a larger sample size that tracked subjects over a longer period of time. The data summarized above failed to do so. The following explanations are offered as possible reasons for the differences in outcome between this study and theirs.

The first explanation centers around the total time span during which the subjects were measured across both studies. The Martinez and Hicks (1986) study tracked subjects' sleep and weight lift logs across a three month period. The present study, on the other hand, tracked subjects across double the time span (6 months) and it may be that the effects observed by Martinez and Hicks cancelled out, or became less salient with the passage of time.

Another factor that may have contributed to the inability of the current study to replicate the findings of Martinez and Hicks (1986) may have been the timing of the two studies, in relation to the workout cycles of the power lifters. Very few of the participants in the present study were either preparing for, or expecting to prepare for an upcoming meet. The importance of this is inherent in the observation that the composition of the work out cycles alter as a function of whether a power lifter is "prepping" for a meet, or if the cycle occurs during a "dead period" either immediately following competition or in between meets. Typically when preparing for an upcoming competition power lifters will work

Table 1.
Standardized Means, and Standard Deviations, for Weight Lift Data across
Sleep Intervals

	Sleep deviation intervals:	N	<u>M</u>	<u>SD</u>
1.	<u>M</u> - 1hr	243	50.5	9.8
2.	<u>M</u> + 1hr	207	49.8	11.7
3.	<u>M</u> - > 1hr < 2hrs	76	48.5	8.0
4.	<u>M</u> + > 1hr < 2hrs	75	49.3	8.9
5.	<u>M</u> - > 2hrs < 3hrs	8	44.3	6.9
6.	<u>M</u> + > 2hrs < 3hrs	18	49.0	8.9
7.	<u>M</u> - > 3hrs	4	51.5	10.0
8.	<u>M</u> + > 3hrs	8	48.0	8.6

Table 2.

One Way Analysis of Variance Results across the Eight Sleep Deviation Intervals

Source	SS	df	MS	F
Sleep Deviations	549	7	78.43	0.76*
Error	64701	631	102.54	
Total	65250	638		

*ns

out according to a regimented six to eight week cycle. This allows the power lifter to work towards his/her maximal competition goal by incorporating incremental increases in his/ her work out. An ideally constructed cycle would allow the power lifter to accomplish his/her desired maximal weight lift just before the scheduled date of the competition so that he/she would enter the meet in prime physical shape.

The observation that very few of the participants under current investigation were either currently gearing up towards a competition or were expecting to gear up for a competition in the near future indicates that they were not engaged in their most intensive workouts and were not attempting a maximal lift on a frequent basis. The majority of the subjects in the Martinez and Hicks (1986) study, on the other hand, were at the time in the process of preparing for a competitive meet and therefore were working towards their maximal lift capability. This difference in subject pool criteria may in and of itself have contributed to the difference in results obtained.

Knowledge that Martinez and Hicks (1986) had recruited actively engaged competitive weight lifters can be gained from inspecting the data analysis procedure used. The data used by Martinez and Hicks centralized around the number of maximal lifts attempted by subjects. A similar analysis for the current study did not yield an acceptable number of data points and thus a decision was made to vary the manner in which the data was analyzed. This difference in analysis methodology may have also contributed towards the differing outcomes of the two studies, and may also have been a significant deviation from the original study to indicate that a direct comparison between the results of the current study and the Martinez and Hicks study cannot be justified.

Regardless of the discrepancies between the results of the current study and the earlier Martinez and Hicks (1986) study, it is apparent that more research needs to be performed to understand more fully the relationship that exists between sleep and exercise. As noted earlier, although the relationship between sleep and exercise has been sufficiently investigated using aerobic capacity as a measure of exercise, not much research has been conducted involving other measures of exercise. Given the wide array of recreational and professional sporting options that are available, there is a demonstrated need

Table 3.

Post Hoc Comparisons for Amount of Weight Lifted across Differing Sleep Deviation Intervals

Comparison #	Intervals**	N	M	SD	t	
1.	> 1hr - <u>M</u> vs.	3, 5, 7	88	48.1	8.1	-0.56*
	> 1hr + <u>M</u>	4, 6, 8	101	48.8	8.8	
2.	< 1hr - <u>M</u> vs.	1	243	50.5	9.8	0.69*
	< 1hr + <u>M</u>	2	207	49.8	11.7	
3.	< 2hrs - <u>M</u> vs.	1, 3	319	49.5	9.4	-0.07*
	< 2hrs + <u>M</u>	2, 4	282	49.5	11.0	
4.	> 2hrs - <u>M</u> vs.	5, 7	12	47.9	8.4	-0.21*
	> 2hrs + <u>M</u>	6, 8	26	48.5	8.6	
5.	< 2hrs +/- <u>M</u> vs.	1, 2, 3, 4	601	49.5	10.2	0.92*
	> 2hrs +/- <u>M</u>	5, 6, 7, 8	38	48.2	8.5	

*ns

**The numbers refer to the number intervals listed in Table 1.

to investigate the association between sleep and exercise by means other than incorporating the treadmill to measure aerobic capacity. Aerobic capacity typically taps into endurance capability and not all sports require endurance as a prerequisite for successful participation in the sport. Understanding the association between REM sleep and a variety of exercises holds practical implications for the millions of Americans who partake in both recreational and professional exercise each day.

Another point of interest that demonstrates the relationship between sleep and exercise revolves around the direction of the relationship. The earlier studies by Bunnell, Bevier, and Horvath (1984) and Angus, Heslegrave, and Myles (1985) investigated the effects of exercise on REM sleep duration. The present study, the Martinez and Hicks (1986) study and the Tinder, Paxton, Montgomery and Fraser (1985) study sought to examine the effects of REM sleep reduction on exercise. The implications of the two directional approaches are vastly different. The findings suggest that reductions of REM sleep duration following exercise may lead individuals to conclude that they should not exercise relatively close to bed time. The results suggesting that reductions in REM sleep increase metabolic rate and therefore increase energy output as evident through exercise, however, indicate that athletes may/may not profit from moderately reducing the amount of REM sleep they engage in per night.

Obviously, the resolution of the directional nature of the relationship between REM sleep and exercise has yet to be accomplished. Much more research, across a variety of sports and athletes, is needed before stronger conclusions may be drawn between REM sleep and exercise.

As a final note, although due to the small sample size ($N = 14$; 10 males and 4 females) it was not possible to investigate the existence of a differential effect of sleep deprivation on exercise and strength for males and females, it is suggested that this may also be of interest in future research.

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Appendix A
Weight Lift and Sleep Log Diary

Representative weight lift log portion of the diary

DATE:

BODY PART WORKED: BACK/BICEPS/FOREARM 5s

HEAVY/LIGHT WORK OUT: HEAVY

WORK OUT:	BENT ROWS:	SET#1: 185
		SET#2: 185
		SET#3: 185 (X4)
	SEAT'D ROW:	SET#1: 210
		SET#2: 210
		SET#3: 210
	PULL DOWNS:	SET#1: 170
		SET#2: 170
		SET#3: 170
	EZ CURL:	SET#1: 125 (X3)
		SET#2: 115 (X5)
		SET#3: 115(X5)
	D.BELL CURLS:	SET#1: 50
		SET#2: 50
		SET#3: 50
	WRIST CURL:	SET#1: 75
		SET#2: 75
	REVERSED	SET#1: 45
	WRIST CURL:	SET#2: 45

Appendix A
Weight Lift and Sleep Log Diary

Sleep Log

SLEEP LOG:

DATE:

TIME STARTED WORK OUT:

TIME FINISHED:

TIME WENT TO SLEEP (PRIOR NIGHT):

APPROXIMATE LAPSE TIME BETWEEN GOING TO BED & FALLING ASLEEP:

TIME WOKE UP THIS MORNING:

TOTAL SLEEP DURATION:

NUMBER OF NAPS TAKEN DURING DAY:

LENGTH OF NAPS:

TOTAL NAP TIME:

Appendix B
Sample Consent Form

**Agreement to Participate in Research
San Jose State University**

RESPONSIBLE INVESTIGATOR: Rashmita Mistry
TITLE OF PROTOCOL: Study of the relationship between sleep and strength as demonstrated by power lifters

I have been asked to participate in a research study that is investigating the relationship between sleep and strength. The results of this study should further our understanding of the correlation that exists between quantity of sleep and its effects on an individuals strength.

I understand that:

- 1) I will be asked to maintain a sleep log, in addition to the lift log that I already maintain for a six month period. The sleep log will encompass recording total sleep time, the time that I went to sleep, the time that I woke up and any naps that I have taken during the day. It will also ask me to record the approximate time that it took me to fall asleep; the time that I began my workout and the time that I finished working out.
- 2) I willingly give my consent for the use by the investigator of any pertinent information available on my personal lift log diary for the purpose of the study.
- 3) No anticipated risks to myself are expected as a result of participation in the study.
- 4) The possible benefits of this study to me are an increased awareness about the possible effect that the amount of sleep that I get has on my ability to lift weights.
- 5) The most advantageous and efficient procedure is being employed by the author for the study.

- 6) The results for the study may be published, but any information from this study that can be identified with me will remain confidential and will be disclosed only with my permission.
- 7) Any questions about my participation in this will be answered by **Rashmita Mistry** (investigator) @ (408) 270-6104. Complaints about the procedures may be presented to **Dr. Robert Hicks** (graduate student advisor) @ (408) 924-5659; or to **Dr. Frank Payne** (Psychology Department Chair) @ (408) 924-5600. For questions or complaints about research subject's rights, or in the event of research-related injury, contact **Serena Stanford, Ph.D.** (Associate Academic Vice President for Graduate Studies & Research) @ (408) 924-2480.
- 8) My consent is given voluntarily without being coerced; I may refuse to participate in this study or in any part of this study, and I may withdraw at any time, without prejudice to my relations with San Jose State University.
- 9) I am aware that my refusal to participate in this study will in no way effect my right to receive services.
- 10) I have received a copy of this consent form for my file.

I HAVE MADE A DECISION WHETHER OR NOT TO PARTICIPATE. MY SIGNATURE INDICATES THAT I HAVE READ THE INFORMATION PROVIDED ABOVE AND THAT I HAVE DECIDED TO PARTICIPATE.

DATE

SUBJECT'S SIGNATURE

INVESTIGATOR'S SIGNATURE

Appendix C
Sample form for Subject Protocol

SUBJECT PROTOCOL
**Study of the Relationship Between Sleep &
Strength as Demonstrated by Power Lifters.**

1. Prior to participation in the study all subjects must have read and signed the consent form.
2. All subjects will be assigned a personal numerical code number to be used for identification purposes.
Be sure to list this code number on both the weight lift log and the sleep log.
Be sure **NOT** to list your name on either the sleep log or the weight lift log.

YOUR PERSONAL IDENTIFICATION NUMBER IS _____.

3. If you are presently maintaining a weight lift log as part of your training program continue to maintain the log in the same format. However, for the study please maintain your weight lift log in **duplicate**. Ensure that you indicate on your log every instance where you attempt a maximal lift. Remember to place your identification number on the duplicate copy of the weight lift log.
4. If you are not currently maintaining a weight lift log, you will need to do so for the purpose of the study. The format of the log is personal preference, however be sure that you indicate any instances where you are going to be attempting a maximal lift. Remember to list your identification number on the weight lift log.
5. You will be given copies of the sleep logs to be maintained during the study. The logs are to be recorded in on a **daily** basis. List the date on each sleep log entry in the top right hand corner.
Be sure to list your personal identification number on each sleep log.

6. At the end of every week staple all of the sleep log entries together.
Staple all of the weight lift log entries together.
For the week clip the weight lift log and the sleep log together.
**CHECK TO ENSURE THAT ALL OF THE SLEEP LOG ENTRIES AND
THE WEIGHT LIFT LOG ENTRIES HAVE THE APPLICABLE DATE AND
IDENTIFICATION NUMBER LISTED ON THEM.**
7. Place the logs in the preprinted envelopes provided, and mail.

Appendix D
Letter From Joseph J. Randazzo

Joseph J. Randazzo
ADFPA Cal. State Chairman
Post Office Box 690386
Stockton, CA 95269-0386
May 1, 1990

Dear fellow A.D.F.P.A. powerlifter,

Last week I spoke with Ms. Mistry about the research she is doing on powerlifters and their workout routines. It is both surprising and interesting that anyone in the field of research has concerns about our sport. In the brief period of time we have already spoken she has provided encouraging information all of us stand to benefit from. At that time I would like to voice my support for her study and request yours. Powerlifting as a whole, and especially those of us in California, should profit from the additional recognition gained from this scientific endeavor. Please donate the nominal time asked for in Ms. Mistry's request.

THANK YOU !

Safe lifting,

Joseph J. Randazzo

Joseph J. Randazzo
Calif. State Chairman