

1994

Resistance training during pregnancy : a critique of present recommendations

Donna Rae Waugh
San Jose State University

Follow this and additional works at: https://scholarworks.sjsu.edu/etd_theses

Recommended Citation

Waugh, Donna Rae, "Resistance training during pregnancy : a critique of present recommendations" (1994). *Master's Theses*. 812.
DOI: <https://doi.org/10.31979/etd.eucg-fs99>
https://scholarworks.sjsu.edu/etd_theses/812

This Thesis is brought to you for free and open access by the Master's Theses and Graduate Research at SJSU ScholarWorks. It has been accepted for inclusion in Master's Theses by an authorized administrator of SJSU ScholarWorks. For more information, please contact scholarworks@sjsu.edu.

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

U·M·I

University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700 800/521-0600



Order Number 1358236

**Resistance training during pregnancy: A critique of present
recommendations**

Waugh, Donna Rae, M.A.

San Jose State University, 1994

U·M·I

300 N. Zeeb Rd.
Ann Arbor, MI 48106



**Resistance Training During Pregnancy: A Critique of Present
Recommendations**

**A Project
Presented to
The Faculty of the Department of Human Performance
San Jose State University**

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

**By
Donna Rae Waugh
May, 1994**

© 1994

Donna Rae Waugh

ALL RIGHTS RESERVED

Approved for the Department of Human Performance

Carol L. Christensen

Dr. Carol L. Christensen

Shirley Reekie

Dr. Shirley Reekie

Susan Wilkinson

Dr. Susan Wilkinson

Approved for the University

Serena N. Stanford

ABSTRACT

RESISTANCE TRAINING DURING PREGNANCY: A CRITIQUE OF PRESENT RECOMMENDATIONS

by Donna R. Waugh

The purpose of this thesis was to write an article for publication critiquing present recommendations on resistance training during pregnancy. The article includes a review of present guidelines and information on potential benefits and detriments to the mother and fetus. In general, examination of current recommendations on resistance training during pregnancy found them to be vague and often conflicting. The completed article was submitted for evaluation to 3 obstetricians/gynecologists (MD's), 4 exercise physiologists (EP's), and 3 certified nurse midwives (CNM's). These specialists were asked to review the article and respond to a questionnaire. The questionnaire consisted of 16 Likert scale questions and 2 open-ended questions about the article. Seven of the ten specialists responded. In general, the specialists responded positively to the article.

The majority responded that the paper was well written and that they had a better understanding of the topic after reading it. The following changes were made in the article due to questionnaire responses: (a) the definition of a specific term and (b) adding a summary of main points to the conclusion.

I would like to thank to my outstanding committee for their effort, patience, and support.

A very special thanks to Dr. Christensen for her interest and belief in this project.

I would also like to thank Debra Fegan for her gentle reminders.

For Tom, Trevor and family, much thanks and love.

Table of Contents

Chapters	<u>Page</u>
I Introduction	1
Statement of Project	3
Significance of the Project	4
Limitations	4
Definition of Terms	4
II Literature Review	5
Conflicts in Guidelines and Recommendations	5
Research	11
Summary	16
III Methods and Article	17
Methods	17
The Article: Resistance Training During Pregnancy: A Critique of Present Recommendations	18
Introduction	19
Past Advice	19
Current Advice	21

Advice From Different Cultures	22
Concerns	23
Joint Laxity	23
Valsalva Manuever	24
Supine Position	26
Hyperthermia	27
Fetal Blood Supply	28
Weight Training Recommendations	29
Weight Limitations	29
Free Weights vs. Machines	32
Experienced vs. Non-experienced	34
Benefits of Resistance Training During Pregnancy	35
Conculsion	38
References	40
IV Results and Discussion	44
V Summary, Changes and Recommendations	54
Summary	54
Changes	54
Recommendations	55

References	56
Appendix A: Cover letter	62
Appendix B: Questionnaire	63

Table of Tables

Table 1. Questionnaire Response Rates	44
Table 2. Responses of Specialists to Questions	45

CHAPTER I

Introduction

Resistance training during pregnancy is as important an issue as aerobic activity during pregnancy. Unfortunately the former topic has generated little research. Despite this fact a multitude of guidelines, opinions, and absolute do's and don'ts can be found on the subject (American College of Obstetricians and Gynecologists, 1985, May; Artal & Subak-Sharpe, 1992; Gauthier, 1986; Mittelmark, Wiswell, & Drinkwater, 1991). Not only are many of these guidelines formed without sound basis, but they are often as nebulous as they are inconsistent. Of course many would ask why any guidelines should be given at all with the small amount of research that has been done. The overwhelming answer to this question is because they are needed.

An estimated number of 15 to 20 million women engage in organized exercise programs (Hall & Kaufmann, 1987) and the number involved in strength training can only be speculated upon. However, the number is probably significant because the National Strength and Conditioning Association (NSCA) found it necessary to prepare a position paper on strength training for female athletes; the reason given for this paper was "the increasing use of resistance exercise by women" (NSCA, 1989, p. 43).

In an article by Gauthier (1986), Harrison C. Visscher, the director of education of the American College of Obstetricians and Gynecologists (ACOG), says that the area of exercise during pregnancy is one in which many physicians feel "inadequate to answer patients' questions about what they can do" (p. 162). The original guidelines from ACOG were published in May of

1985, along with many subsequent articles and two books. They have all helped to shape the recommendations on aerobic and strength exercises given to pregnant women. But do the present guidelines help or confuse physicians and other health professionals? Not only are there varying opinions on the subject of resistance training during pregnancy, but different articles from the same source can be contradictory.

In light of the conflicting views regarding this issue, whose advice will physicians follow? It will probably depend on which piece of information is available to him or her. If the physician has kept current on the issue, perhaps he/she will have many pieces of information and will choose to err on the conservative side. Due to the fear of malpractice and litigation, this is a likely possibility. Pat Kulpa, an obstetrician and gynecologist from Grand Rapids, Michigan, suggested that the ACOG guidelines might become a form of prevention from litigation because they are so general (Gauthier, 1986). She also commented, "I think because malpractice and litigation are so high, they (the committee) are trying to cover their butts" (Gauthier, p. 168). Perhaps the best advice comes from the NSCA (1990) in their position paper on strength training for female athletes which suggests that due to lack of data, "of course common sense should be used when selecting training intensities, exercises and loads during critical stages of pregnancy" (p. 21). This statement, however, is much too general and certainly does not answer even the basic questions regarding resistance training in pregnancy. In addition one might question the use of the term "common sense," which has been defined as "the unreflective opinions of ordinary men" and "sound and prudent but often unsophisticated judgment" (Mish, 1987, p. 266). Despite the small amount of research in this

area, surely it is possible to come up with some guidelines based on something more than unreflective opinions and unsophisticated judgement. However, looking at the profusion of conflicting and often baseless guidelines, it looks like "common sense" may have been overused. This confusion in the guidelines is indeed unfortunate considering this statement from the coordinator of the exercise and pregnancy project for the Melpomene Institute in St. Paul (a non-profit research and resource center for health concerns of physically active women) "The average layperson or health professional who doesn't have other information of course relies on these guidelines. They may become the final word" (Val Lee, quoted in Gauthier, 1986, p. 168). Physicians, other health professionals, and the general public are in need of consistency regarding these guidelines. In addition, each individual recommendation is in need of an in-depth look as to its validity

Statement of the Project

The purpose of this project was to write an article for publication in Strength and Conditioning, the professional journal of the National Strength and Conditioning Association (NSCA). The article will cover the issue of resistance training during pregnancy. It will provide a better understanding of present guidelines and recommendations and how they may affect the mother and the fetus. As Strength and Conditioning serves a varied audience, the article will be written accordingly.

Significance of the Project

At the present time, there is much conflict in guidelines regarding resistance training during pregnancy. The confusion in this area needed to be addressed. A compiling of information was needed to sort out differences in the recommendations and to critique them. Once this is accomplished, an indepth look at the possible beneficial or detrimental results of such a program (during pregnancy, labor, and postpartum) will allow physicians and other health care providers to make better decisions regarding their clients' participation in exercise programs.

Limitations

Critiques of the existing guidelines were limited to available research studies, books and articles on the subject.

Definition of Terms

Weight Resistance Training is a systematic program of exercise for the development of the muscular system (Heyward, 1991). The word "weight" has been dropped in this paper to shorten the terminology.

Valsalva maneuver is the process of making a forceful attempt at expiration while holding the nostrils closed and keeping the mouth shut (Pease, 1986).

CHAPTER II

Literature Review

This review of literature first examined the conflicts in guidelines or recommendations on resistance training during pregnancy. Next followed an assessment of the research done in this area.

Conflicts in Guidelines and Recommendations

Conflicts in literature regarding resistance training during pregnancy can be found as early as 1985, when guidelines were first being formed. The American College of Obstetrics and Gynecologists (May, 1985) states that during pregnancy "the ideal exercise program will offer women a variety of options...including calisthenics" (p. 3), while its September 1985 bulletin states "calisthenics are safe for most pregnant women regardless of prior exercise habits, but promote neither fitness nor strength" (p. 4). In this same September ACOG bulletin on women and exercise the statement is made that "stronger back muscles may prevent or reduce low back pain during pregnancy" (p. 4); however, if one is to follow the original guidelines published in May of the same year it is stated that many of the "traditional back strengthening exercises" are not recommended because they require the supine position or the Valsalva maneuver. Of course it is hard to visualize just what kind of back strengthening exercises requiring the supine position the ACOG had in mind. Perhaps they meant abdominal strengthening exercises which would be performed in the supine position and would be part of a back care regimen.

Assuming that the pregnant woman is neither supine nor exhibiting the Valsalva maneuver, would back strengthening exercises really help to reduce low back pain? Low-back pain has been shown to occur sometime during pregnancy in 56-82% of women (Fast et al., 1987; Bullock, Jull & Bullock, 1987; Berg, Hammar, Moller-Nielsen, Linden, & Thorblad, 1988). In one study most women were shown to start having pain between the fifth and seventh month of pregnancy (Fast et al., 1987). The authors also found a statistically significant difference between Hispanic and Caucasian women, with the later having more back pain. The authors felt this may be due to the typically higher socioeconomic class of the Caucasian women. The authors reasoned that the Caucasian women might lead easier lives than the Hispanic women resulting in weak musculature. They stated "the fact that 45% of the patients do not complain of pain remains unexplained. It could be that individuals with higher fitness level and specifically stronger trunk musculature, tend to suffer less from back pain than those who are less fit" (p. 370). The study by Berg et al. (1988) found that two-thirds of the women who suffered with severe back-pain during pregnancy had dysfunctional sacroiliac joints. They suggested that this finding may be due to hormonal effects which cause instability in the pelvis. Jill McNitt-Gray, an assistant professor of exercise sciences and director of the Biomechanics Research Laboratory at the University of Southern California, commented that low-back pain might be reduced by "improving the strength, endurance, and control of the muscles attached to the spine and pelvis" (Artal, Friedman, & McNitt-Gray, 1990, p. 94). Given the instability within the pelvis that may be caused by hormones, this would seem to be a rational approach.

Another controversial topic affecting resistance training during pregnancy is the supine position. This position is used in several resistance exercises including the bench press and abdominal work. In the ACOG's May 1985 document it is stated that after the fourth month of gestation, no exercise should be performed in the supine position. It is reported that this position may cause compression of the vena cava (Davis, 1989), possibly resulting in fetal hypoxia. However, other articles state that if there is a problem one can tell immediately (Gauthier, 1986), and that the mother will become dizzy, faint, or nauseous before any harm comes to the fetus (Rote, 1987). These conclusions were based on the idea that the woman would exhibit signs of hypotension if the vena cava were compressed; this problem occurs in about 10% of pregnant women (Backe et al., 1983). Davis (1989) addressed this side of the issue, by saying some believe that since such a small number of pregnant women experience vena cava symptoms, "Why direct a class and guidelines to the rare exception instead of the other 95 percent of pregnant exercisers they ask?" (p. 54). A review article on research done in this area shows the dangers of this position during pregnancy were first noted as early as the 1940's (Marx & Bassell, 1982). Holmes (1960) found that the severity of this syndrome was reduced when the fetal head became "engaged" in the pelvic brim. This usually occurs in the last trimester, between 36 and 40 weeks (Kitzinger, 1989). By 1964 there was evidence that the vena cava becomes virtually occluded in the supine position during pregnancy (Marx & Bassell, 1982). Blood that should travel up the caval vein is rerouted through other veins, and these vessels are unable to take on the increased volume at a suitable rate to maintain circulatory homeostasis during rest. In order to maintain systemic blood pressure,

peripheral vasoconstriction must occur. Therefore, "women who were able to increase their systemic vascular resistance in response to obstruction of the inferior vena cava showed no outward sign of their inward physiological turmoil, whereas those who were unable to compensate suffered the supine hypotensive syndrome" (Marx & Bassell, p. 260).

A more recent study (Backe et al., 1983) found no changes in maternal or fetal circulation while subjects were lying supine for approximately 10 minutes. The study used newly developed equipment for measuring fetal aortic velocities. A small group of seven women were observed so serial measurements of fetal average velocities could be used to test the reliability of this method. The second small group (n=10) in the study (median gestational week 39.5) were observed to determine posture-dependent changes in fetal and maternal aortic velocities. During a pilot study using the new apparatus a sudden decrease in fetal heart rate was observed twice while mothers were in the supine position. A definite lowering of fetal aortic velocities during this time was shown. The authors state that "as only insignificant changes in fetal aortic blood velocity takes place when the mother lies supine, the study indicates that the fetal circulation is not significantly altered by the supine impairment of placental blood flow in pregnant women with no supine hypotension" (Backe et al., p. 593). They do conclude that because of the two cases of supine fetal bradycardia more research in this area is needed. It is possible that a larger sample size would have shown significant changes. In addition, the use of near-term pregnant women may have skewed results since the fetus may have already become engaged and reduced the compression of the vena cava.

To add to the confusion, the ACOG bulletin on women and exercise (September, 1985, p. 4) states that "Aerobic exercise and weight training should be encouraged on a regular basis" and that "regardless of prior exercise habits and level of fitness, most healthy pregnant women without medical or obstetric complications can lift weights safely and beneficially." However, the book Exercise in Pregnancy (Mittelmark et al., 1991) disagrees with this. The authors state that inexperience may be the cause of one of the potential problems during weight lifting (e.g., transient hypertension caused by the Valsalva maneuver). Artal (also known as R. A. Mittelmark), a prominent researcher in this area and one of the authors of the book Exercise in Pregnancy, states that he wrote the ACOG guidelines because they were based largely on his research (Gauthier, 1986). Unfortunately his book is in direct conflict with the ACOG bulletin of September 1985, a bulletin whose guidelines were supposedly based on his research. ACOG's article on how to exercise safely during pregnancy (ACOG, 1992, March) is even less enthusiastic about resistance training during pregnancy than the others, and suggests that a woman talk to her doctor if she is already lifting weights and wishes to continue.

A concern for those not accustomed to resistance training is maternal catecholamine levels. Hall and Kaufmann (1987) found that because maternal exercise may increase the possibility of fetal hypoxia by excessive catecholamine production "it may be potentially beneficial to condition the expectant mother before the onset of the greatest physical stress she and her fetus will experience during the course of pregnancy, labor and delivery. Animal studies suggest that such conditioning is beneficial" (p.1201). However, even this concern for the woman inexperienced in resistance training may be

unwarranted due to the findings of studies done in this area (Rabinovici et al., 1985; Hall & Kaufmann, 1987).

Finally, in the book Pregnancy and Exercise (Artal & Subak-Sharpe, 1992), a book geared toward the general public, the statement is made that "if you are already involved in heavy weight-bearing exercises like weight lifting or rock climbing, switch to more moderate activities like walking, swimming, and working with a stationary bicycle" (p. 24). The book goes on to say "Weight lifting is not an activity we recommend for pregnant women" (p. 112). Despite these statements, guidelines are given for weight lifting stressing the use of machines, small weights of 4.4 to 11 pounds and 8 to 12 repetitions of 8 to 10 exercises at least twice a week. It is also interesting to note that ACOG guidelines in Artal and Subak-Sharpe's book recommend that "light weights (1 to 3 kg., 2 to 5 pounds) should be used to prevent injuries to joints and ligaments" (p. 63). Should physicians and other health professionals instruct pregnant women to follow weight guidelines by the ACOG or by Artal and Subak-Sharpe? Artal offers his guidelines despite his statement in an article by Work (1989) "As a doctor, I feel that patients should not start an exercise program that has not been tested, and there are no data on the rates of injuries or long-term effects of weight training" (p. 258). Mona Shangold, who was an original member of the panel that developed the 1985 the ACOG guidelines, had this to say about Artal's recommendations, "There are rather sweeping conclusions that are not based on his or any other data. He recommends do this and this, but his advice doesn't reflect the data he presented in his book" (Gauthier, 1986, p. 165).

Research

Actual studies on resistance training during pregnancy are admittedly few. Most are focused on short periods of static exertion while evaluating maternal catecholamines and cardiovascular responses, as well as fetal heart rate responses. Maternal catecholamine responses are important because, if excessive, they may cause fetal hypoxia (Hall & Kaufmann, 1987). This is one of the major concerns for exercise during pregnancy. Brainum (1990) lists hypoxia as a major concern during aerobic training but not resistance training. However, he may not have been taking catecholamine response into consideration. A study involving fourteen pregnant women examined the possible contribution of isometric muscle exercise to the rise in norepinephrine, because of the tremendous static effort required during the second stage of labor (Rabinovici et al., 1985). During the active first stage of labor, blood samples were obtained twice: at the end of a regular contraction, and at the end of a similar contraction while performing a maximum effort hand grip exercise with both arms for 2.5 minutes. No significant rise in maternal catecholamines was found, although a trend towards increased concentrations was observed. The study reports this increased concentration in the pregnant woman to be much lower than that observed in the non-pregnant after a submaximal hand grip contraction. This led the authors to conclude:

Our findings suggest that the pregnant organism is protected during labor from excessive adrenergic output by a yet unclear mechanism. Thus, stimuli sufficient to cause increased adrenergic activation in the non-pregnant (woman) do not lead to similar results in the pregnant (woman). This could explain the lower than expected noradrenalin values found by most

authors during labor at a stage where pain, anxiety, stress, and physical strain should raise catecholamine levels to unprecedented high values (Rabinovici et al., p. 181).

A study by Barron, Mujais, Zinaman, Bravo, and Lindheimer (1986) confirms this finding, stating that "pregnancy alters the response of the sympathetic nervous system to upright posture and isometric exercise in that increments in heart rate and norepinephrine levels are attenuated in gestation" (p. 84). A conflicting conclusion to the above findings is seen in another study (Nisell, Hjemdahl, Linde & Nils-Olov, 1985). They found similar increments in heart rate and plasma norepinephrine levels in both pregnant and postpartum women. However, this may have been due to a design flaw in the study. Arterial plasma levels were examined rather than venous levels. According to Barron et al. "the latter (venous levels) reflect catecholamines produced by the sympathetic activity within the forearm" (p. 84). Although more research is needed on this topic (Rabinovici et al., 1985; Wolfe et al., 1989) it appears that if the pregnancy is normal, "haemodynamic responses to static exertion are not excessive during pregnancy" (Wolfe et al., 1989, p. 295).

Fetal heart rate response (FHR), being a clinical indicator of fetal well-being has been examined in two studies. In the first study twelve women (3 fit, 9 sedentary) performed a static handgrip, at 30% of their maximum contraction, to fatigue (Wolfe, Lowe-Wylde, Tranmer, & Mcgrath, 1988). There were no changes in mean FHR baseline or FHR baseline variability, however, the frequency of mild transient FHR decelerations increased significantly. The authors felt that these FHR decelerations may have been a fetal adaptation to mild hypoxia due to increased maternal catecholamine output and peripheral

vasoconstriction. All of the subjects "delivered normal healthy infants with no major obstetric complications" (p. 96).

The second study involved 26 women (gestational age 36-40 weeks) performing a series of static antenatal exercises in the supine position (Green, Schneider, & MacLennan, 1988). This choice of exercises was made because some "are used along with more dynamic exercises in other antenatal education programs in South Australia" (p. 3). Many of the eight exercises can not be called static contractions, or indeed exercises at all. Some were merely positions that were assumed for five minutes each. For example the seventh "exercise" was described as follows: "whilst lying supine the patient 'sat' on her feet with knees flexed" (p. 4). It is hard to imagine anyone being asked to do this "exercise" especially a woman in her last trimester of pregnancy. The total duration of these exercises was 35-40 minutes, all in the supine position. Four women in the study showed FHR abnormalities before exercise was begun, and three of them had abnormal perinatal outcomes. Eight additional subjects showed a deceleration or reduced reactivity and variability in FHR and two of these individuals had abnormal perinatal outcomes. One woman's baby was delivered with signs of fetal distress. The other 13 subjects delivered with normal FHR responses and no birth outcome abnormalities. The authors concluded that it was not possible to show in their study that the exercises had any direct effect on the pregnancy outcome, but felt that they may have unmasked symptoms of underlying fetal compromise. They did report their results to be far from reassuring in regard to the safety of traditionally taught exercises. It is arguable however, just how traditional these exercises were. It is also questionable how much this study contributed to the literature in this

area when there is so much information refuting the supine position for even short periods of time (Mittlemark et al., 1986; Marx & Bassell, 1982). Perhaps a more helpful study would look at abdominal work in the supine position for a shorter amount of time. This exercise would be far more beneficial to the pregnant woman and would not require 35-40 minutes to accomplish.

Hall and Kaufmann (1987) studied the effects of aerobic and strength conditioning on pregnancy outcomes. They followed 845 subjects who participated in a program of low, medium or high intensity exercise, or served as controls. The program was designed to control catecholamine production and minimize exaggerated postural changes of pregnancy. Results of the study showed no significant differences in times of labor. However the high-intensity exercise group had the lowest rate of caesarean section (6.7% versus 28.1% in the control group), had the highest birth weights (approximately 150 grams higher in the high intensity exercise group than for babies of the control group), had babies with slightly higher 1 minute Apgar scores (8.9 versus 8.6 for controls), and had a slightly shorter stay in the hospital than the control group (2.2 versus 2.9 days, respectively). Fetal heart rate "remained normal in all cases. At no time was fetal bradycardia observed as a result of the aerobic or anaerobic exercise stimulus" (p. 1201). When surveyed post partum, all the subjects reported that the conditioning program gave them an improved self-image and decreased "the common discomforts of pregnancy as long as they participated" (p.1201). A return of many of the aches and pains associated with pregnancy (particularly low-back pain) and a decline in self-image was observed in those who discontinued the program for more than two weeks. All patients found relief of tension with adherence to the program and those who

continued it until the onset of labor felt the exercise program was helpful during labor and delivery. Those who were multiparous also reported a more rapid recovery than after previous pregnancies.

Another, perhaps more important, reason for strength training during pregnancy is its link to better self-esteem. An article by Moore (1978) showed that "the more obviously pregnant a woman became, the poorer her image of herself" (p. 17). Much research has been done in the area of exercise and self esteem, and recent articles have been written on the subject of weight training and women. Trujillo (1983) studied the effects of weight training and running exercise on the self-esteem of college women and found both groups increased self-esteem significantly. However, while 35% of the running group was reported to feel both physically and psychologically better, 83% of the weight training group felt similarly. Another study of strength training and self-concept in females reported significant changes in young and mature groups (Brown & Harrison, 1986). A third study examined the self-esteem differences in strength training for 2 and 3 days per week (Brazell-Roberts & Thomas, 1989). The interesting finding in this study was that the 3-day per week group had a significantly decreased body fat while the 2-day per week did not. Despite this fact, both regimens were equally effective in increasing the self-concept of college women. According to Venezia (cited in Moore, 1978) though some women may have a more positive attitude toward their pregnancy than others this does not mean they have a more positive attitude toward their body.

Summary

It would seem that resistance training could be beneficial in many ways, including the preservation or improvement of self esteem in the pregnant woman. A major problem to overcome in this area is the conflict in the existing guidelines and recommendations. A review of these guidelines to ascertain which have a sound basis will hopefully allow them to become something more than a safeguard for litigation. A better understanding of the benefits, as well as the possible problems, of resistance training during pregnancy will allow the pregnant woman to take advantage of those benefits while maintaining safety for herself and her baby.

CHAPTER III

Methods and Article

This chapter includes information about the article, as well as the methodology involved in submitting the questionnaire to specialists. In addition, the article itself has been placed in this chapter.

Methods

The article, "Resistance Training During Pregnancy: A Critique of Present Recommendations", was written for publication in Strength & Conditioning: the professional journal of The National Strength and Conditioning Association.

The article includes: (a) a review of the present guidelines for resistance training during pregnancy and the postnatal period, (b) a review of research studies, books and articles to ascertain if there is a sound basis for individual guidelines, (c) a description of any potential benefits and/or detriments to the mother or fetus, and (d) a critique of weight training recommendations.

The completed article was evaluated by submitting it, a cover letter (see Appendix A), and a questionnaire (see Appendix B), to 10 specialists. These were three obstetricians, four exercise physiologists, and three certified nurse-midwives (all were women) who were selected due to their experience. In addition, they were selected because of the likelihood that they would be asked for advice on resistance training during pregnancy. The physicians were chosen from the Santa Cruz County telephone directory. Those who were chosen appeared to have offices that were particularly sensitive to women's

issues (they offered "natural" childbirth, nurse-midwives, "warm and personal health care for women"). The exercise physiologists were selected San Jose State graduates. Of the certified nurse-midwives one was selected from the Santa Cruz County telephone directory, one was the author's own midwife, and the third was recommended by the author's midwife. Within 5 days of sending the questionnaire a phone call was made to each of the specialists to introduce the author and impress upon her the author's appreciation for their response. After two weeks, those who had not responded were again phoned to let them know how valued their input was to the project and to thank them for any time spent of the questionnaire. Four weeks were allowed for the return of responses.

The specialists were instructed in a cover letter to review the paper and answer the questionnaire as directly as possible. Questions 1 through 7 used Likert scaling where 1= strongly agree, and 5= strongly disagree. In addition there was a space for written comments after each question. Questions 8 and 9 were open-ended questions that requested any further suggestions for improving the paper. Responses were tabulated, but no statistical analysis was done since the number of evaluators was small.

The Article

Comments from evaluators were used to revise the article. The revised edition is presented here.

Resistance Training During Pregnancy: A Critique of Present Recommendations

Introduction

It has been reported that of the 10 most popular activities for the active woman, weight lifting ranks fourth (20). A recent report noted that 22% of working women weight train regularly (19). These findings hold no surprise considering the growing popularity of this sport. Women have learned of the benefits of resistance training and have been encouraged by reports of increased self-esteem, strength, and lean body weight. Unfortunately, once women become pregnant these proposed benefits are often outweighed by the concern of injury (to the mother and/or fetus) and liability (of physicians and other health care professionals). Liability, a major concern for health care practitioners in this country, is no doubt increased when it involves exercise guidelines for pregnant women. The American College of Obstetricians and Gynecologists (ACOG) has been criticized for setting a legal standard of care with guidelines that are too basic to be of use and that are not effective for women who are already physically active (14). Exercise guidelines for the pregnant woman are vague and often conflicting and there is little research on resistance training during pregnancy.

Past Advice

This problem of conflicting views, and questionable advice on physical activity during pregnancy, however, is an old one. Historically, the best information to be offered to women regarding physical activity during pregnancy

was a mixture of unscientific advice and extreme moderation. Advice of this sort was given as early as the 18th century, when "improper exercise" was discouraged including "dancing and whatever disturbs the body or mind" (20, p. 1). Although there was a general acceptance and a feeling that activity could be beneficial, there were certain limits. As might be expected, the Victorian era brought with it more confining views. During this time it was recommended that the "happier class" of women continue the exercise or labor they were accustomed to, while upper class women were advised to "live indolently and feast luxuriously" (20, p.1). By 1892 moral implications were being cited as a reason to limit physical activity. An 1895 textbook on American obstetrics cautioned pregnant women against indulgence in strenuous sports (13). The author of a 1916 obstetrics book felt that "good roads" were a requirement when walking or riding (13). Early 20th century advice for pregnant women had a dominant theme, limited walking and large quantities of fresh air. Modern Motherhood, a 1935 book, stated that the idea of walking to make birth easier was a superstition. Seven years later, another book reported walking to be "the most satisfactory form of exercise" and suggested that it strengthened muscles used during labor (20, p. 4).

Grantley Dick Reed wrote his first book on the subject of birth preparation in 1944 (24). He felt that the pain of childbirth stemmed from socially induced expectations about pain. It was the fear of childbirth, he believed, that caused the process to be painful. Therefore, he concluded that the pain could be eliminated by dealing with misapprehensions and informing women about labor and birth. In addition, a series of breathing and other exercises were advocated to encourage relaxation and ease labor. In the same year it was discovered

that the incidence of premature birth was not increased by traveling by plane, train, or boat (13). The mainstream thoughts were, however, still very traditional, relying heavily on moderation and fresh air for the pregnant woman. By 1958 a new method of childbirth was introduced to the West by Lamaze. The belief was that labor pain was not a disease and should not be treated as such (i.e., drugs should not be used). By 1980 it was claimed that successfully completing an exercise program could give an expectant mother greater control over her body which, along with the ability to relax, would give her the confidence to "let go for a smoother labor and delivery" (20, p. 5).

Current Advice

Currently the "moderation theme" is still supported by the most well known authority on exercise during pregnancy, ACOG. In Exercise During Pregnancy and the Postnatal Period, ACOG warns readers of the "societal pressures to exercise today" and states, "It is noteworthy that no evidence exists to support the popular notion that regular exercise will improve the outcome of pregnancy" (1, p. 1). In fact there is little to be said about the benefits of exercising for the pregnant woman in their revised version of Exercise During Pregnancy and the Postnatal Period. However, a brochure that advertises the ACOG pregnancy and postnatal exercise videos, states that "you can increase your energy level, improve your mood, enhance your looks, and feel better with this easy-to-use pregnancy video library."

In a patient education pamphlet called Exercise and Fitness: A Guide for Women, ACOG advises nonpregnant women on the topic of weight loss by stating "fat cells will be replaced with muscle" (5). Fortunately many of the patients probably already know that fat cells cannot be "replaced" by muscle,

because fat cells do not leave the body when weight loss occurs, they only become smaller. This is a humorous and harmless mistake, but it does raise a question about the reliability of some of the ACOG literature. This pamphlet also advises that staying active can help to reduce backache, constipation, fatigue, bloating and swelling and that exercise can help you to adjust to carrying the extra weight gain of pregnancy because it promotes muscle tone, strength, and endurance. This all suggests that ACOG is presenting mixed views of exercise during pregnancy.

Advice from Different Cultures

Unlike the United States and Europe, many cultures have maintained rather consistent views about activity during pregnancy. The book Childbirth Wisdom (15) describes pregnancy in tribal societies. Within these societies women are physically active throughout pregnancy, almost without exception. Most continue work rather than quit in the last few months of pregnancy. Their work often consists of pounding grain and fetching water or firewood, not sitting behind a desk or standing at a counter. Tribal women are advised to refrain from sitting too long without moving, to rise early in the morning, and to avoid sleeping too much; lethargy, in particular, is to be avoided. If the work-load of a tribal woman is reduced at all it is done so gradually as the pregnancy progresses. Some societies in the South Pacific and southeast Asia believe in increasing the work-load as pregnancy progresses. For example, in New Guinea "heavy burdens" during the first few months are avoided, while activity is considered necessary during the later stages of pregnancy. Women are advised to "walk about vigorously, climb quickly over obstacles, and swim a few

strokes when bathing" (15, p. 7). The book Birth Traditions and Modern Pregnancy Care (24) reported that Guatemalan women believe that those "who fail to clean her grinding stone or tie her loom promptly" will have a longer and more difficult delivery (p. 58).

Concerns

Information on physical activity for pregnant women in Western cultures has focused almost exclusively on aerobic activity. Considering the other important elements of physical fitness this is truly an oversight. Various specialists have expressed several concerns regarding resistance training during pregnancy. Concerns include, joint laxity, the use of the Valsalva maneuver, the supine position, hyperthermia, and diminished blood flow to the fetus.

Joint laxity.

Most authorities are particularly concerned about joint laxity during pregnancy. Joint laxity is increased during pregnancy as a result of a hormone called relaxin which is produced in the ovaries and detectable only during pregnancy. It helps to facilitate delivery and also helps to maintain pregnancy; it is therefore present from the time of the missed menses (29). In fact, the serum concentration of this hormone is greatest in the first trimester and tapers in the last two trimesters (29). Relaxin levels finally decline to normal within 3-7 days postpartum; however, its anatomic effects can remain as long as 12 weeks (20). This suggests that caution over joint laxity is warranted for a full year, starting from the time of the missed menses and into postpartum. Joint laxity during a second pregnancy has been found to be significantly increased over that in a first pregnancy (11), warranting further caution in multigravidae women. In fact,

a study on the biomechanics of the spine noted that one of the most important risk factors for lumbar disc disease is a previous term pregnancy (31); perhaps this is due, in part, to the increased level of relaxin.

The National Strength and Conditioning Association's (NSCA) current position paper Strength Training for Female Athletes (22) cautions against heavy multi-joint free weight exercises after the first trimester; however, it would be prudent to include the first trimester due to the increased levels of relaxin at this time. Raul Artal M.D., Professor of Obstetrics, Gynecology and Exercise Sciences at the University of Southern California stated that, "The change in joint laxity during pregnancy is analogous to that in someone who has just had surgery on the joints and ligaments" and warns, "You wouldn't start that person lifting heavy weights; you'd start with very low-intensity rehabilitative exercise" (32, p. 258). In a prepregnant state bone and soft tissue adapt to mechanical loads they are exposed to; however, connective tissue loosening along with changes in mechanical loading during pregnancy may cause serious mechanical consequences (20). The book Exercise in Pregnancy states that "participation in one type of dynamic activity may produce beneficial loading" (20, p.140). This idea is shared by Gary Reinl who developed Pregna Systems, a program that provides physical medicine and rehabilitation during the pregnancy year. He feels that if joints are lax during pregnancy then strengthening them, as in any rehabilitation program, would be beneficial.

Valsalva manuever.

Another concern is the Valsalva manuever, which has been described as "making an expiratory effort with the glottis closed" (8, p. 18). It is a technique

that can be beneficial when lifting heavy weight because it stabilizes the abdominal and chest cavities. This results in added support to the vertebral column, which in turn may enhance a muscle's ability to lift heavy weight. Therefore, it is felt by some that this technique may improve performance during a maximal lift. Exercises that are thought to benefit from the Valsalva maneuver are those in which a stable trunk is required, specifically, squats, pulls, and cleans; any standing exercises such as, curls and rows; and exercises requiring a stable chest cavity such as bench and incline presses. Breathing is necessary to maintain a normal intrathoracic pressure, venous return, and cardiac output. Failure to breath (or use of the Valsalva maneuver) can drastically increase intrathoracic pressure. This can result in limited venous return, cardiac output, blood flow to the brain, and erratic blood pressure. Signs of such responses include headaches, dizziness, and fainting. This, in turn, could lead to an increased risk of musculoskeletal injury and ruptured blood vessels.

The Valsalva maneuver poses an array of problems to the pregnant woman. For starters, cardiac output is normally increased during pregnancy, as is blood volume (40-50%), resulting in an increased workload on the heart. It is possible that these changes could enhance the problems associated with the Valsalva maneuver. One such result is the possibility of decreased perfusion of the uterus resulting in fetal hypoxia. In a study measuring brachial and popliteal blood pressures it was determined that aortic compression (which results in reduced blood flow to the fetus) could be worsened due to maternal bearing down efforts (18). The authors of the study called this bearing down effort a maternal Valsalva maneuver. Proper breathing is stressed in two books on

exercise during pregnancy (7; 20). Austin and colleagues (8) state, "It appears as though you would be better off if you didn't need to interrupt normal breathing (using the Valsalva maneuver)" (p. 26). This statement appears to be even more true during pregnancy due to the increased risk to the mother and fetus. The article also states that "we need to balance these risks against the need for a stable spine during most of our heavy lifts." A recent article that recommends pregnant women lift "heavy weights" presents a problem (32, p. 258). If the Valsalva maneuver is used to aid in a heavy lift, risks already inherent to the procedure may be increased due to pregnancy. If the maneuver is not used there is a possible increased risk of spinal injury. Therefore, the use of heavy weights requiring the use of the Valsalva maneuver during pregnancy remains highly questionable and risky. The authors of ACOG guidelines and the book Exercise in Pregnancy recommend that the Valsalva maneuver be avoided.

Supine position.

The use of the supine position during exercise is another area that evokes disagreement among specialists. Those who find a problem with this position do so because of the possibilities of aortic compression and inferior vena cava obstruction. In an article on the subject, Dr. Pat Kulpa noted that most pregnant women can tolerate lying on their backs unless at high risk for complications (14). The article states that the problems associated with the supine position are not as common as ACOG guidelines imply. ACOG recommends that no exercise be performed in the supine position after the fourth month of pregnancy. Dr. Kulpa adds that many women can be found in labor rooms lying on their backs unattended. However, just because this has been the practice

does not mean it is safe. Marx and Bassell (18) reviewed studies on the supine position during pregnancy and found that the position was thought to be hazardous as early as the 1940's. In a 1953 study it was noted that the supine position was "not a natural posture for pregnant or laboring women" and was "assumed purely for the convenience of the obstetrician" (18, p. 256). Aortic compression, as measured by a femoral pressure decrease, occurs as early as the 19th week of gestation. Inferior vena cava obstruction, as evidenced in a reduced brachial blood pressure, does not occur before the 28th week of gestation. Susan Regnier, author of the YMCA's "You and Me Baby" program, claims that she uses many exercises requiring the supine position for pregnant women (14). She is quoted as saying "All you need to do is place a woman on her back, if there is a problem with low blood pressure you can tell immediately and just help her off her back" (p. 169). Unfortunately, only approximately 10 percent of women will become aware of uncomfortable symptoms when lying supine (18). The majority would have no subjective reason to warn them to avoid the supine position. In addition to the above recommendations by Marx and Bassell, and ACOG, two books advise that the supine position should be avoided while exercising in general, or lifting weights (20; 7).

Hyperthermia.

Hyperthermia during pregnancy (when core temperature exceeds 39 C) has been linked to neural tube defects. This defect occurs early in pregnancy. Both pregnancy and exercise increase metabolic rate and heat production, making hyperthermia an important issue during exercise. Thermoregulation is maintained solely by the mother, as the fetus has no ability to dissipate heat. However, during early pregnancy the thermal effect of exercise may be naturally

decreased because: (a) both exercise and pregnancy cause an increase in blood flow to the skin allowing for the dissipation of heat; (b) thermal inertia (the body's heat threshold), thought to increase by about 4% due to early weight gain, buffers a rise in core temperature; and (c) the initial cooling effects from peripheral venous pooling along with an observed fall in resting core temperature help keep maternal temperature under control (20). James F. Clapp, M.D., a Professor of reproductive biology at Case Western Reserve University School of Medicine, observed that "pregnant women become much more effective at getting rid of heat" (26, p. 61).

During moderate weight training, however, it is unlikely that hyperthermia would be a problem. Dr. Shangold noted that during moderate weight training core temperature does not rise significantly (32). Even engaging in strenuous exercise for 15 minutes will usually not increase core temperature beyond 38 C. (20). The NSCA encourages attention to dress and environmental conditions to avoid hyperthermia when lifting weights.

Fetal blood supply.

The concern about diminished blood supply to the fetus (fetal hypoxia) is an important consideration when engaging in aerobic activity. The diversion of blood from the internal organs to the working muscles and skin during exercise, may affect fetal oxygen supply (26). However, Dr. Artal reports that blood flow to the uterus would need to be reduced by more than 50% to cause fetal hypoxia (26). To elicit such a reduction it is felt that exercise would need to be "strenuous and prolonged" (26, p. 61). Dr. Clapp has observed that the increase in blood volume during pregnancy may decrease the risk of fetal

oxygen deprivation (26). Therefore, during moderate weight training, reduced blood flow to the fetus may not be an issue unless the Valsalva maneuver is used.

Weight Training Recommendations

Despite the lack of research concerning resistance training during pregnancy there appears to be a wealth of advice and it is conflicting. Areas of disagreement regarding this subject are recommended weight levels, use of free weights versus machines, experience versus no experience, and supervision versus no supervision.

Weight limitations.

A 1986 book had this to say of the dilemma, "Although recently the medical community has failed to research and establish prenatal exercise programs systematically based on scientific rationale, social reformers and sports advocates have promoted highly specific programs lacking scientific evaluation or follow-up" (20, p. 5). Unfortunately the authors fell victim to their own criticism, going as far as to suggest weight limits for pregnant weight lifters for which there is no research and little scientific rationale. In another book Artal and Subak-Sharp (7) stated that "weight lifting is not an activity we recommend for pregnant women," then went on to give specific do's and don'ts including weight limits (4.4-11 lbs) and the advice "avoid the use of free weights" (p. 112). Many people might have a problem using these narrow weight limits for all women and for all muscle groups. However, it cannot compare to the problem they would have finding machines with the recommended weight limits. With such problems occurring in the advice given to pregnant women it would

indeed seem prudent that those making recommendations use research and scientific rationale to support their guidelines. More specifically or, perhaps simply, those making recommendations should be able to back them up.

Recommendations for resistance training during pregnancy, even when offered by "specialists," can lack common sense. For example, some recommend the same weight limits to all pregnant women. In two books on exercise during pregnancy (both of which include Dr. Artal as an author), switching from heavy to very light weights is said to be necessary to prevent injuries to joints and ligaments that normally loosen during pregnancy (20; 7). However, if the concern is that joint laxity increases the risk of injury, will creating hypothetical weight limits offer more safety? Both books give weight guidelines of 4.4 to 11 pounds for pregnant women. There are no such weight levels recommended for the general population because they would be meaningless without knowing the person's strength. Strength is generally measured by using an important concept developed over 40 years ago called repetition maximum (RM). A RM is the maximal load a muscle or muscle group can lift a given number of times before fatiguing. One person may be able to lift 50 pounds 8 times before fatiguing, while another may be able to lift 100 pounds 8 times before fatiguing. Obviously they would not be advised to lift the same amount of weight in their training programs. Usually a person lifts a certain percentage or percentages of their RM when training. This same approach would seem particularly important to the pregnant woman due to the possible increased risk of injury. If the goal is to advise a woman to use "light weights," then telling her to use a lower percentage of her RM would be far more representative of her ability and/or limitations than giving her the same

weight levels as every other pregnant woman. Dr. Artal stated that the recommended weight levels are arbitrary and that using low weight is the key (R. Artal, personal communication, March 26, 1993). However, by listing specific poundages of 4.4 to 11 lbs in a book, it is not likely that they will be looked upon as being arbitrary. It is much more probable that they will be taken literally. In addition, by recommending weight levels there is a risk that a person may be injured at that level, just as there is a possibility that a person may not benefit at that level. If the weight guidelines in both books are taken literally they would not allow a pregnant woman to pick up her own toddler. If the more conservative limits by ACOG are followed (2-5 lbs) as outlined in Artal's book (1992, p. 63), a pregnant woman would be unable to lift weights comparable to the force it takes to open a refrigerator door. Can the guidelines being set be appropriate and helpful if they do not allow a woman to lift weights equal to her normal daily activities?

In biomechanics related to exercise in pregnancy (20) Jill McNitt-Gray, an assistant professor of Exercise Science in the Department of Exercise Sciences at the University of Southern California, reviewed the kinematics of a pregnant woman rising from a chair. In this study there was a significant increase in joint forces (23%-83%), a 100% increase in the activity of the quadriceps muscles, and a 35% increase in the activity of the hamstring muscles over the forces and activity levels found after delivery. She stated that "the increased muscular effort needed to accomplish this relatively simple task suggests that pregnant women may benefit from strength training of the lower extremities" (20, p. 135). McNitt-Gray noted that strength training of the upper extremities may also be beneficial to pregnant women if the arms are used to assist her in rising from a

chair (which results in reduced tibiofemoral and patellofemoral force). If increased strength is thought to aid a pregnant woman when rising from a chair then it is likely to be helpful in other daily activities as well. In fact, the only study to include weight training during pregnancy has shown pregnancy outcomes to be more favorable in the exercise groups, especially in the high-exercise group (16). The authors noted a decreased caesarean rate, higher Apgar scores (indicating a healthier baby), and a slightly shorter hospital stay. Positive subjective responses to the conditioning program included increased self image, tension relief and a decrease in common discomforts in pregnancy such as back pain.

Free weights vs. machines.

The issue of free weights versus machines for the pregnant woman is particularly problematic. The book Pregnancy and Exercise (7) advises pregnant women not to use free weights, although no reasons are given. The book Exercise in Pregnancy (20) reasons that it is safer to use machines since this reduces the risk of dropping weights on the fetus and because spotting would not be necessary. Unfortunately if a woman were to follow this recommendation and use weight machines when she arrived at her local gym she would find that the lowest weight level on some machines are higher than the recommended weight levels. In general, weight machines start at 10 pounds, but some begin at 20 pounds. The incremental increase possible is also 10 to 20 pounds, depending on the weight machine. Pregnant women using weight machines at the advice of Dr. Artal might find it difficult to find machines within his 4.4 to 11 pound range. If they were able to find a machine

that started at 10 pounds, they may find it too heavy and risk injury. If a woman wanted to increase the weight with these heavy increments she might risk excessive overload. In fact it has been recommended that to avoid excess overload, weight increments for the general population should be, at the most, 2.5 pounds (27). One of the benefits of free weights is that they are widely available in much smaller weight increments. Although using them may require the use of a spotter, this might be a small price to pay for pregnant women to avoid excessive overload. In addition, because weight machines are single joint exercises, joint stability would not be gained as it would be using free weights (23). A positive aspect of weight machines is that they isolate muscle groups, allowing an individual to concentrate on a particular area of weakness (23). Recently machines have become available with lower weight increments. Last year Nautilus designed machines that start out at a lower weight (10 lbs) and increase in smaller increments (3.3 lbs) than other machines. However, with a starting weight of 10 pounds they are still at the far end of the 4.4 to 11 pound guideline; and they are far beyond the ACOG guidelines (2-5 lbs) presented in Pregnancy and Exercise. In addition, this does little for the average woman using a local gym, because these machines would probably not be available. Even if the machines currently found in gyms had lower weight increments, would they be safer than free weights for the pregnant woman?

A problem inherent to weight machines is that they are generally not built to accommodate a variety of body types and sizes, particularly a pregnant body. Thus, it is possible that a woman would either not be able to execute the exercise through its full range of motion, or not be able to perform the exercise.

In addition, using a machine that does not allow correct alignment during the exercise could increase the risk of injury to a joint already compromised during pregnancy. It is important for machines to be adjustable; however, this feature may not be available to women who only have access to older machines. If the machine is adjustable, then it is imperative that the pregnant woman know how to correctly align her joints and the axis of rotation to assure proper execution of the exercise.

Experienced vs. non-experienced.

If a pregnant woman does lift weights, should she be experienced? Does she need supervision? Apparently there is little agreement on these questions among specialists. In 1985 ACOG advised that most healthy pregnant women could lift weights regardless of prior exercise habits and level of fitness, and went so far as to say that it could be done safely and beneficially. That technical bulletin has been replaced, and the new one has no reference to weight lifting, or indeed, pregnant women (4). Currently there is no information available on weight lifting during pregnancy from ACOG except for a paragraph in the book Pregnancy and Exercise (7). Guidelines apparently will be available from ACOG later this year (R. Artal, personal communication, March 26, 1993). In Exercise in Pregnancy it is advised that heavy weight lifting be avoided or be done only under strict prescription and supervision (20). Pregnancy and Exercise lists prior weight lifting experience as a must, as well as strict supervision (7). Mona M. Shangold MD, director of the Sports Gynecology Center at Georgetown University in Washington DC, advises that women without prior weight training experience can lift, but should get instruction from an exercise specialist (32). In order to lift weights in a safe manner, the

pregnant woman must be familiar with her type of resistance training. In the case of machines, she needs to know the importance of joint/axis alignment, and she needs to be wary of excessive overload due to the high increments. While she may have a better chance of selecting weights reflective of her ability by using free weights, she will need to be able to control the weight. In both of these cases it would seem unlikely that an inexperienced person would be aware of these problems, much less the other problems associated with weight training during pregnancy. Generally, any person who is not familiar with weight training should seek instruction in the beginning. It would seem impractical if the same were not done by pregnant women inexperienced with weight training. However, those instructing a pregnant woman will not only need to be well versed in weight training, but must have a good understanding of the potential problems associated with exercise during pregnancy. Even pregnant women with experience in weight training may not understand what a Valsalva maneuver is or when to begin worrying about joint laxity. Therefore, unless a woman has knowledge of both correct lifting procedures and the problems she may encounter due to pregnancy, it would seem questionable for her to lift without supervision. However, adequate supervision may be hard to find. As mentioned, even specialists may not be capable of answering both medical and exercise science concerns. The questions in this issue will be better answered by not only more research, but a meeting of minds between physicians and those in exercise science.

Benefits of Resistance Training During Pregnancy

Benefits that may result from weight training during pregnancy include a better ability to cope with the changes of the body, a better ability to handle

labor, a decrease in back pain, and increased self esteem . It has been suggested that "muscular strength enhances one's ability to maintain erect posture, move the body efficiently in gait, carry out occupational and recreational tasks efficiently, and cope with physically demanding emergencies" (3, p. 1). All of these changes would be particularly beneficial to the pregnant woman, and some would serve to help her cope with the many changes that will occur in her body. Certified nurse midwife, Rebecca Ecklund-Fitzhum noted that "it takes strength and agility to cope with the physical changes pregnancy brings" (28, p. 8). Dr. McNitt-Gray stated that resistance training might help to compensate for the postural changes and weight gain during pregnancy (6, 1990). Other authors stated that "a well-conditioned body will perform better and more reliably under the stress of labor than a body that is in poor physical condition" (12, p. 26). While studies have not proven that labor is shorter with either aerobic activity or resistance training during pregnancy, exercise may help women tolerate pain better (26).

Gary Reinl's program for pregnant women, Pregna systems, includes resistance exercise. In a proposal written in 1992 (25) he suggests that back pain during pregnancy is a problem, not a normal state, of pregnancy. He states that, "Regardless of the statistical onset of back pain or its specific manifestation, the pregnant woman can expect to experience from several to many months of pain and/or dysfunction, which may change over the course of her pregnancy. There is no question that back pain is a significant problem for pregnant women despite the misdirected medical attitude that back pain and/or dysfunction is a normal state during pregnancy" (p. 2). As a result he observed that treatment is often "piecemeal and symptomatic." McNitt-Gray suggested

that pain in the low back region during pregnancy may be reduced by increasing the strength and control of muscles that are attached to the spine and pelvis (20). The abdominals lengthen as pregnancy progresses and their effectiveness at reducing anterior pelvic tilt is lessened. The additional force needed to maintain an anterior pelvic tilt must come from the hamstrings. Therefore, a woman with pain due to an anterior pelvic tilt may benefit by increasing hamstring strength. A woman with low back pain due to a posterior pelvic tilt may find relief by strengthening the erector spinae and the iliopectas and rectus femoris, and stretching the hamstrings and abdominals. This very approach was taken by the authors of the maternal and strength conditioning study (16) in which subjects worked to either strengthen or increase the flexibility of muscle groups depending on the results of each individual evaluation. Douglas Hall MD, an obstetrician-gynecologist from Ocala, Florida reports that pregnant women in his study had a decrease in back pain. He is also the designer of a health club for pregnant women called Pregnagym that utilizes Nautilus, Cybex, or Bodymaster weight machines, as well as aerobic equipment. A woman is tested for strength and flexibility, and there is a review of her medical history and physician's recommendations prior to establishing a training program for her. It is Dr. Hall's belief that his weight-training program helps to counteract shoulder and back pain (29). Dr. Artal also noted that resistance training can help prevent lower-back pain (29, p. 62), and stated that so many complain of this problem during pregnancy that it seems reasonable to use exercises that strengthen the back (6).

It has been reported that body image during pregnancy is generally far from positive (21). Moore observed that the more obviously pregnant a woman

became, the poorer her self-image. Some feel that exercise during pregnancy helps to raise a pregnant woman's self-esteem. Dr. Clapp reported that pregnant women who exercise "don't come across with the same depressive, negative feelings" as women who don't exercise (26, p. 63). In the same article, Dr. Hall reported that exercise helps the pregnant woman keep a sense of control. They are playing an active role instead of letting pregnancy just happen to them. There is evidence that resistance training raises self-esteem in women (9; 10; 30). As has been stated, "Perhaps the most important advantage of exercise in pregnancy is an improved mental outlook and self-image during gestation" (17).

Conclusion

A lot can be learned by looking back over the vague and conflicting guidelines of the past. Doing so emphasizes the fact that these same shortcomings exist in present guidelines. This review of current recommendations has uncovered what current research, or lack of it, indicates. Caution should be used due to joint laxity from the beginning of pregnancy and into postpartum depending on the individual (approximately 12 months). The Valsalva maneuver should be avoided during pregnancy, as well as the supine position (after the fourth month), particularly during exercise. While hyperthermia seems unlikely during moderate weight training, it is a concern for the pregnant woman and should be avoided. Diversion of fetal blood supply to the working muscles during weight training is a concern. This is not thought to occur unless exercise is strenuous or prolonged; however, until further research is done moderate weight training is recommended. Guidelines on how much weight a pregnant woman should lift are both arbitrary and without scientific

substantiation. Until further research is done, it is not known at what level a woman can lift before causing injury to herself or her fetus. Even with the research, however, these guidelines would have to allow for individual variation in strength and experience. The advice to avoid the use of free weights is also unfounded. There are benefits and detriments to both free weights and machines. As with the general population, the less experienced may benefit from machines. The more experienced lifter is likely to find free weights a safe alternative; however, only research can answer this question. Certainly guidance from a specialist prior to weight training for all pregnant women is recommended. Even the experienced lifter may be unaware of the many changes that the body undergoes during pregnancy. Inexperienced lifters may benefit from one-on-one instruction from a specialist when they lift, to insure they are doing so in a safe manner.

By keeping what are supposed to be general guidelines general, we allow for individualization. Even the general population requires individualization when prescribing exercise programs. This approach is certainly needed for pregnant women, because in addition to their different body types and abilities, they also experience the complex changes pregnancy brings. However, in realizing the need for care and concern, the benefits that can be gained from resistance training during pregnancy such as increased self-esteem, reduction in back pain, and possibly others, cannot be overlooked. Even though there is disagreement among specialists as to which of the proposed benefits actually occur, there seems to be a general agreement that there are benefits. Perhaps through further research they will be proven.

References

1. American College of Obstetricians and Gynecologists. 1985, May. ACOG home exercise programs: Exercise during pregnancy and the postnatal period.
2. American College of Obstetricians and Gynecologists. 1985, September. ACOG technical bulletin #87: Women and exercise.
3. American College of Obstetricians and Gynecologists. 1986, May. ACOG home exercise programs: Safety Guidelines for Women who Exercise (document).
4. American College of Obstetricians and Gynecologists. 1992, September. ACOG technical bulletin #173: Women and Exercise.
5. American College of Obstetricians and Gynecologists. 1992, December. Exercise and Fitness: A guide for women (Pamphlet).
6. Artal, R., Friedman, M. J., and McNitt-Gray, J. L. 1990. Orthopedic problems in pregnancy. The Physician and Sportsmedicine, 18(9): 93-105.
7. Artal, R., and Subak-Sharpe, G. 1992. Pregnancy and Exercise. New York: Delacorte.
8. Austin, D., Roll, F., Kreis, E. J., Palmieri, J., and Lander, J. 1987. Roundtable: Breathing during weight training. National Strength & Conditioning Association Journal, 9 (5): 17-25.
9. Brazell-Roberts, J. V., and Thomas, L. E. 1989. Pumping iron and self-esteem. Swimming Technique, 26: 21-23.

10. Brown, R. D., and Harrison, J. M. 1986. The effects of a strength training program on the strength and self-concept of two female age groups. Research Quarterly for Exercise and Sport, 57(4): 315-320.
11. Calguneri, H., Bird, H. A., and Wright, V. 1982. Changes in joint laxity occurring during pregnancy. Annals of the Rheumatic Diseases, 41: 126-128.
12. Desanto, P. & Hassid, P. (1983, Spring). Evaluating exercises: stability and control are hallmarks of safe prenatal exercises. Childbirth Educator, pp. 26-31.
13. Diddle, A. W. 1984. Interrelationship of Pregnancy and Athletic Performance. Journal of the Tennessee Medical Association, 77(5): 265-269.
14. Gauthier, M. M. 1986. Guidelines for exercise during pregnancy: too little or too much? The Physician and Sportsmedicine, 14(4): 162-169.
15. Goldsmith, J. 1990. Childbirth Wisdom. Brookline, Mass: East West Health Books.
16. Hall, D. C., and Kaufmann, D. A. 1987. Effects of aerobic and strength conditioning on pregnancy outcomes. American Journal of Obstetrics and Gynecology, 57: 1199-1203.
17. Maeder, E. C. 1985. Effects of sports and exercise in pregnancy. Postgraduate Medicine, 77(2): 112.
18. Marx, G. F., and Bassell, G. M. 1982. Hazards of the supine position in pregnancy. Clinics in Obstetrics and Gynecology, 9(2): 255-271.
19. Miller Lite Report. 1993, March. Miller Lite report on sports and fitness in the lives of working women.

20. Mittlemark, R. A., Wiswell, R. A., and Drinkwater, B. L. 1991. Exercise in Pregnancy. Baltimore: Williams & Wilkins.
21. Moore, D. S. 1978. The body image in pregnancy. Journal of Nurse Midwifery, 22(4): 17-27.
22. National Strength and Conditioning Association. 1990. Position paper on strength training for female athletes.
23. Pauletto, B. 1987. Strength training versus weight lifting. National Strength & Conditioning Association Journal, 9(4): 65-67.
24. Priya, J. V. 1992. Birth Traditions & Modern Pregnancy Care. Rockport, Mass: Element.
25. Reinl, G. (1992). Pregna Systems Proposal. Unpublished manuscript.
26. Schlosberg, S. 1993, Summer. Work out now, labor less later? Shape Pregnancy Guide, pp. 58-63.
27. Smith, M. S. 1987. Improving the design of weight training machines. National Strength & Conditioning Association Journal, 9(3): 42.
28. Sutter, G. 1991, April. Exercise and pregnancy: A healthy combination. Babytalk, pp. 8.
29. Szlachter, B. N., Quagliarello, J., Jewelewicz, R., Osathanondh, R., Spellacy, W. N., and Weiss, G. 1982. Relaxin in normal and pathogenic pregnancies. Obstetrics & Gynecology, 59(2): 167-170.
30. Trujillo, C. M. 1983. The effect of weight training and running exercise intervention programs on the self-esteem of college women. Journal of Sport Psychology, 14: 162-173.
31. White, A. & Panjabi, M. (1978). The basic kinematics of the human spine. Spine 3: 12-20.

32. Work, J. A. 1989. Is weight training safe during pregnancy? The Physician and Sportsmedicine, 17(3): 257-259.

CHAPTER IV
Results and Discussion

A total of 10 specialists were sent copies of the paper "Resistance Training During Pregnancy: A Critique of Present Recommendations." In addition, they received a cover letter (see Appendix A) and a questionnaire with 18 questions relating to the paper (see Appendix B). A total of 7 responses were returned (Table 1). All of the Certified Nurse-Midwives (CNM) and Exercise Physiologists (EP) responded. Three of the Obstetrician/Gynecologists (MD) did not answer and/or return the questionnaire. One of these returned the paper and unanswered questionnaire with a note stating that she did not appreciate receiving articles to review "without even the courtesy of a phone call."

Table 1
Questionnaire Response Rates

Response Rates

	CNM <u>Certified Nurse Midwives</u>	EP <u>Exercise Physiologists</u>	MD <u>Obstetrician Gynecologists</u>	<u>Total</u>
Sent Out	3	4	3	10
Returned	3	4	0	7

Responses of specialists are given in Table 2. In general the responses towards the article were positive.

Table 2

Responses of Specialists to Questions 1-7

CNM (N=3) EP (N=4)

	strongly agree	agree	undecided	disagree	strongly disagree
1. I have advised pregnant women on this topic.					
CNM	1	1	1		
EP	2	1		1	
2. I would advise differently after reading the paper.					
CNM		1		2	
EP		1	1	2	
3. I had a good understanding of this topic before reading this paper.					
CNM	1	2			
EP	2	1		1	
4. The author addressed this issue in an unbiased manner.					
CNM		2		1	
EP		3	1		

	strongly agree	agree	undecided	disagree	strongly disagree
--	-------------------	-------	-----------	----------	----------------------

5A. This paper adequately covers the topic of past advice.

CNM	1	2			
EP	1	3			

5B. This paper adequately covers the topic of joint laxity.

CNM	1	1	1		
EP	1	3			

5C. This paper adequately covers the topic of the Valsalva manuever.

CNM	1	1		1	
EP	2	2			

5D. This paper adequately covers the topic supine position.

CNM	1	1		1	
EP	2	2			

5E. This paper adequately covers the topic of hyperthermia.

CNM	1	1		1	
EP	1	2	1		

5F. This paper adequately covers the topic of fetal blood supply.

CNM		2		1	
EP	1	3			

	<u>strongly agree</u>	agree	undecided	disagree	<u>strongly disagree</u>
--	---------------------------	-------	-----------	----------	------------------------------

5G. This paper adequately covers the topic of weight limitations.

CNM		1		2	
EP	3	1			

5H. This paper adequately covers the topic of free weights vs. machines.

CNM	1			2	
EP	4				

5I. This paper adequately covers the topic of experienced vs. non-experienced.

CNM	1	1		1	
EP	1	3			

5J. This paper adequately covers the topic of benefits of resistance training during pregnancy.

CNM	1	1			1
EP		4			

6. I have a better understanding of this topic after reading this paper.

CNM		2			1
EP	3	1			

strongly agree agree undecided disagree strongly disagree

7. The paper is written in a clear and concise manner.

CNM	1	1		1
EP	2	2		

For question 1, "I have advised pregnant women on this topic," one EP had an additional comment, "I have designed/restructured many exercise programs for pregnant women over the years." There were two additional comments for question 2, "I would advise differently after reading the paper." One EP added "I would be able to be more precise in my recommendations." Another EP stated "I have always approached exercise prescription in a case by case manner rather than one plan works for all." For question 3, "I had a good understanding of this topic before reading this paper," one CNM commented, "This enhanced my belief of the importance of exercise."

For question 4, "The author addressed this issue in an unbiased manner," one EP commented, "The author in general seems displeased with currently available guidelines, yet backs these biases with good logic." Another EP responded, "I'm not sure if it was the author, or the fact that I know the author, or just my own bias, but I sensed a frustration around the amount of conflicting, arbitrary advice." One EP had a comment for question 5B, "This paper adequately covers the topic of joint laxity." She asked, "What is an example of a 'Heavy multi-joint free weight exercise'?" Would 10 Reps of a partial squat be contraindicated? What about a dip where shoulder-elbow line did not go

beyond parallel? I did these and more during pregnancy." The NSCA does not go into this much detail on lifting, no doubt due to the lack of research in this area. It is possible that this kind of lifting would be too much for the average pregnant woman. This respondent, however, appears to have quite a lot of experience in this area and found these exercises to be safe for her.

Unfortunately, guidelines will only be able to become more specific when there is more research on this topic. Therefore, the guidelines will need to stay general to allow for individualization as is stated in the article.

Question 5C, "This paper adequately covers the topic of the Valsalva maneuver," had an additional comment from an EP, "I think you can stabilize your spine without closing the glottis since most people (not just preggers) do not do such heavy lifting that they need to stabilize abdominal and chest. I think cautions around the Valsalva maneuver are overstated unless someone is a complete beginner who might hold their breath while lifting or if someone is a power lifter who is used to training maximally all the time." This individual is probably correct in stating that it is the inexperienced and those who train particularly hard that would be more likely to use the Valsalva maneuver. It is more than likely, however, that this is a significant number of the weight lifting population. Add to this the increased risk of possible injury to the mother and fetus, and the concern for overstating this issue seems less important than the understating of it.

For question 5D, "This paper adequately covers the topic of the supine position," an EP made this comment, "The book "While Waiting" given to me by Dr. Mumm encourages crunches. I don't remember stopping. I think the caution was that if the abdominals separated to a width of 2+ fingers then to stop." A

strong abdominal wall is very much encouraged for pregnant women. Ideally, the abdominal wall should be strong prior to pregnancy. During pregnancy women can then continue to do traditional abdominal work (eg., crunches) until the fourth month according to ACOG. After this time (as stated in the article) there are studies that indicate that the supine position should be avoided during pregnancy, particularly while exercising. The concern this respondent had about separation of the abdominal wall is called Diastasis Recti. This concern was not included in the article because it is generally accepted as a potential problem for pregnant women by all specialists, and was not, therefore, an area of conflict.

For question 5E, "This paper adequately covers the topic of hyperthermia," there was an additional comment from one EP, "Definition/explanation of thermal inertia?" The definition of thermal inertia was added to the paper as a result of this specialist's comment. On question 5G, "This paper adequately covers the topic of weight limitations," one CNM commented, "Common sense" is one of the most important ingredients in working with pregnant women." For question 5J, "This paper adequately covers the topic of benefits of resistance training during pregnancy," there was a comment by an EP, "Maybe these could have been outlined and discussed the same way "concerns" were though I don't know if there are enough studies out there. One benefit perhaps understated was the fact that weight training can help maintain lean tissue (I hate the word "tone") which maintains metabolic rate which can help with fat loss. I also think that weight training can help you with the incredible body soreness after delivery. I found the sensations of delivery soreness and powerlifting soreness very similar-It helped me to know that it would dissipate in

a couple of days. I also really believe that pre-post partum exercise helps mom's maintain a sense of self and a tiny bit to control in their lives and that it gives them better energy for the incredible demands of motherdom. I think this is the most important benefit of weight training." Although the benefits that this individual has incurred through weight training have been voiced by others, there is a lack of research to prove it. Therefore, this section of the paper was not outlined in the same manner as the section "concerns." One comment was made on question 6, "I have a better understanding of this topic after reading this paper," by an EP, "Even though I had a good understanding of this subject, I can now be more precise and I now have a complete, concise reference."

Responses from CNM to question 8, "Is there any other information that you believe should be included in this paper?" are as follows.

"Pretty well covered."

"I would like to see a very short summary of recommendations I could use as a handout. Many women have an umbilical hernia. What is recommended in this case? Also I would like back strengthening exercises. Good work."

"I think you tried to cover too much. I don't think you presented the scientific evidence well--it was not substantiated well. A lot of opinions from this person or that. You need to quote the actual study and say what they found. Nothing is ever proven--its all theory. I know you worked hard on this but it doesn't flow. I can't really advise you without re-reading a lot of original work. I don't know what the expectation level of your school is of your paper."

Responses from EP to question 8 included the following.

"More on lean tissue maintenance."

"Include summary of main points in the conclusion. In general, a very interesting subject and paper."

Responses of CNM to question 9, "Is there any part of this paper you feel should be omitted? Why?" are as follows.

"I think exercise and conditioning during pregnancy are vital and certainly do make for better outcomes and feelings of well-being among women. It's amazing how our modern way of medicine-ACOG ignore the principal activity of third world women."

"Many times I thought you should rearrange things. Maybe get a more precise question on resistance training and defend it more specifically. Sorry to be so negative. My paper took a long time too. I hope this helps. If I had more free time I could be more thorough."

The following are responses from EP to question 9.

"Great stuff I can't believe how "wimpy" the info is out there. "Do whatever you want, for as long as you feel comfortable. If it's not comfortable then stop." Dr. Mumm (OBGYN) to me after learning I was an experienced weight trainer."

Despite the general positive responses, one CNM was consistently different from the majority of the specialists and was particularly critical of the paper. This individual was very detailed as to what she found to be flaws in the paper and also took the time to make comments on the paper itself. One of her main objections to the paper was that she felt it needed more support from additional studies in the area, and that it should not contain information from "lay" magazines. The intention of the article, however, was to emphasize the fact that there is a lack of scientifically substantiated information in this area, and that even with this knowledge specialists in this area are being very specific with

with guidelines. The use of unrefereed articles, while unusual, served a purpose in this instance. These references often quoted the most well known authorities in the area of exercise and pregnancy and are almost certain to influence those reading the articles in the way they instruct pregnant women. Any material that was believed to have an impact on how specialists advise pregnant women was included. In addition, the CNM stated that she felt the paper covered too much, needed to be rearranged, and did not flow. This feeling, however, was not shared by the rest of the specialists who responded favorably to a question on the clearness and conciseness of the paper. For this reason the basic writing of the paper remains unchanged. It is possible, however, that this paper could have been strengthened by combining chapters I through V together into one comprehensive paper. This would have increased the number of refereed journal articles related to the topic. In addition, one of the goals of this paper was to write for a varied audience as the Strength & Conditioning Journal author guidelines require. A sentence in the cover letter alluding to this fact may have helped the respondents by identifying the purpose of the paper, as well as the population it was intended for.

CHAPTER V

Summary, Changes and Recommendations

Summary

Most of the specialists responded positively to the paper. The majority had already advised pregnant women on this topic. While only a few responded that they would advise differently after reading the article, the majority responded that they had a better understanding of the topic after reading it. The majority also felt that the paper was written in a clear and concise manner. This was reflected in the way the specialists responded to questions about the body of the paper. Of the 10 questions on the body of the paper, the topic of past advice was the most highly rated, followed by the topic joint laxity. The questions on the Valsalva maneuver, supine position, fetal blood supply, experienced vs non-experienced, and benefits were responded to positively by 6 of the 7 specialists. The questions receiving more negative responses were hyperthermia, with one undecided and one disagree, and weight limitations and free weights vs machines, both with 2 specialists undecided.

Changes

The specialists' responses to the questionnaire were utilized to improve upon the article. The article was revised, and includes the following changes:

1. The conclusion was strengthened by including a summary of main points.
2. A definition of thermal inertia was included.

Recommendations

The following recommendations are made for other projects involving the writing of an article for publication.

1. Strive to produce one comprehensive paper if possible.
2. If a survey is needed, include information about the population that you are writing for in the cover letter.
3. If possible, make contact with the individuals to be surveyed prior to sending out questionnaires. This may enhance response rate by identifying specific populations or individuals that will not respond.

References

- American College of Obstetricians and Gynecologists (1985, May). ACOG Home Exercise Programs: Exercise During Pregnancy and the Postnatal Period.
- American College of Obstetricians and Gynecologists (1985, September). Women and Exercise. (Technical bulletin No. 87).
- American College of Obstetricians and Gynecologists. (1992, March). How to exercise safely during pregnancy. Babytalk, pp. 24-26.
- American College of Obstetricians and Gynecologists. (1992, September). ACOG technical bulletin #173: Women and Exercise.
- Artal, R., Friedman, M. J., & McNitt-Gray, J. L. (1990). Orthopedic problems in pregnancy. The Physician and Sportsmedicine, 18(9), 93-105.
- Artal, R., & Subak-Sharpe, G. (Eds.). (1992). Pregnancy and Exercise. New York: Delacorte.
- Austin, D., Roll, F., Kreis, E. J., Palmieri, J., and Lander, J. (1987). Roundtable: Breathing during weight training. National Strength & Conditioning Association Journal, 9 (5): 17-25.
- Backe, B., Brodtkorb, C. J., Giltvedt, J., Kvernes, S., Brubakk, A. O., Torp, H. & Angelsen, A. J. (1983). Fetal and maternal aortic flow in two different maternal positions. Ultrasound in Medicine and Biology, 9(6), 587-593.

- Barron, W. M., Mujais, S. K., Zinaman, M., Bravo, E. L., & Lindheimer, M. D. (1986). Plasma catecholamine responses to physiologic stimuli in normal human pregnancy. American Journal of Obstetrics and Gynecology, 154, 80-84.
- Berg, G., Hammar, M., Moller-Nielsen, J., Linden, U., & Thorblad, J. (1988). Low back pain during pregnancy. Obstetrics and Gynecology, 71(1), 71-75.
- Brainum, J. (1990, May). The littlest training partner. Muscle and Fitness, pp. 174-214.
- Brazell-Roberts, J. V., & Thomas, L. E. (1989). Pumping iron and self-esteem. Swimming Technique, 26, 21-23.
- Brown, R. D., & Harrison, J. M. (1986). The effects of a strength training program on the strength and self-concept of two female age groups. Research Quarterly for Exercise and Sport, 57(4), 315-320.
- Bullock, J. E., Jull, G. A., Bullock, M. I. (1987). The relationship of low back pain to postural changes during pregnancy. The Australian Journal of Physiotherapy, 33(1), 10-17.
- Calguneri, H., Bird, H. A., and Wright, V. (1982). Changes in joint laxity occurring during pregnancy. Annals of the Rheumatic Diseases, 41: 126-128.
- Davis, K. (1989, June). Pregnant and fit. Woman's Sports and Fitness, pp. 50-54.
- Desanto, P. & Hassid, P. (1983, Spring). Evaluating exercises: stability and control are hallmarks of safe prenatal exercises. Childbirth Educator, pp. 26-31.

- Diddle, A. W. (1984). Interrelationship of Pregnancy and Athletic Performance. Journal of the Tennessee Medical Association, 77(5): 265-269.
- Fast, A., Shapiro, D., Ducommun, E. J., Friedmann, L. W., Bouklas, T., & Floman, Y. (1987). Low-back pain in pregnancy. Spine, 12(4), 368-371.
- Gauthier, M. M. (1986). Guidelines for exercise during pregnancy: too little or too much? The Physician and Sportsmedicine, 14(4), 162-169.
- Goldsmith, J. (1990). Childbirth Wisdom. Brookline, Mass: East West Health Books.
- Green, R. C., Schneider, K., & MacLennan, A. H. (1988). The fetal heart response to static antenatal exercises in the supine position. The Australian Journal of Physiotherapy, 34(1), 3-7.
- Hall, D. C., & Kaufmann, D. A. (1987). Effects of aerobic and strength conditioning on pregnancy outcomes. American Journal of Obstetrics & Gynecology, 157, 1199-1203.
- Heyward, V. H. (1991). Advanced Fitness Assessment and Exercise Prescription. Human Kinetics: Champagne, Illinois.
- Holmes, F. (1960). Incidence of the supine hypotensive syndrome in late pregnancy. Journal of Obstetrics and Gynaecology of the British Empire, 67, 254-258
- Kitzinger, S. (1989). The complete book of pregnancy and childbirth. Alfred A. Knopf: New York
- Maeder, E. C. (1985). Effects of sports and exercise in pregnancy. Postgraduate Medicine, 77(2): 112.

- Marx, G. F., & Bassell, G. M. (1982). Hazards of the supine position in pregnancy. Clinics in Obstetrics and Gynecology, 9(2), 255-271.
- Miller Lite Report. (1993, March). Miller Lite report on sports and fitness in the lives of working women.
- Mish, F. C. (Ed. in Chief). (1987). Webster's Ninth New Collegiate Dictionary. Springfield, MA: Merriam-Webster Inc. Publishers.
- Mittlemark, R. A., Wiswell, R. A., & Drinkwater, B. L. (Eds.). (1991). Exercise in Pregnancy. Baltimore, MD: Williams & Wilkins.
- Moore, D. S. (1978). The body image in pregnancy. Journal of Nurse Midwifery, 22(4), 17-27.
- National Strength and Conditioning Association. (1989). Strength training for female athletes: A position paper: Part I. NSCA Journal, 11(4), 43-55.
- National Strength and Conditioning Association. (1990). Position paper on strength training for female athletes.
- Nisell, H., Hjemdahl, P., Linde B., & Nils-Olov, L. (1985). Sympatho-adrenal and cardiovascular reactivity in pregnancy-induced hypertension. I. Responses to isometric exercise and a cold pressor test. British Journal of Obstetrics and Gynaecology, 92, 722-731.
- Pauletto, B. (1987). Strength training versus weight lifting. National Strength & Conditioning Association Journal, 9(4): 65-67.
- Pease, R. W., Jr. (Ed.). (1986). Webster's Medical Desk Dictionary. Springfield, MA: Merriam-Webster.
- Priya, J. V. (1992). Birth Traditions & Modern Pregnancy Care. Rockport, Mass: Element.

- Rabinovici, J., Rosental, T., Peleg, E., Rabau-Friedman, I., Mordechai, D., & Mashiach, S. (1985). The effect of isometric exercise on plasma norepinephrine during labor. In M. Suzuki (Ed.), Perinatal Care and Gestosis (pp.179-182). Elsevier Science Publishers B. V.
- Reinl, G. (1992). Pregna Systems Proposal. Unpublished manuscript.
- Rote, B. (1987, Jan-Feb). Pregnancy the aerobic way: Guidelines and helpful tips for teaching pregnant students. Aerobics & Fitness, pp.16-19.
- Schlosberg, S. (1993, Summer). Work out now, labor less later? Shape Pregnancy Guide, pp. 58-63.
- Smith, M. S. (1987). Improving the design of weight training machines. National Strength & Conditioning Association Journal, 9(3): 42.
- Sutter, G. (1991, April). Exercise and pregnancy: A healthy combination. Babytalk, pp. 8.
- Szlachter, B. N., Quagliarello, J., Jewelewicz, R., Osathanondh, R., Spellacy, W. N., and Weiss, G. (1982). Relaxin in normal and pathogenic pregnancies. Obstetrics & Gynecology, 59(2): 167-170.
- Trujillo, C. M. (1983). The effect of weight training and running exercise intervention programs on the self-esteem of college women. Journal of Sport Psychology, 14: 162-173.
- White, A. & Panjabi, M. (1978). The basic kinematics of the human spine. Spine 3: 12-20.
- Wolfe, L. A., Hall P., Webb, K. A., Goodman, L., Monga, M., & McGrath, M. J. (1989). Prescription of aerobic exercise during pregnancy. Sports Medicine, 8(5), 273-301.

Wolfe, L. A., Lowe-Wylde, S. J., Tranmer, J. E., & Mcgrath, M. J. (1988). Fetal heart rate (FHR) during maternal static exercise. Canadian Journal of Sports Sciences, 13, 95P-96P.

Work, J. A. (1989). Is weight training safe during pregnancy? The Physician and Sportsmedicine, 17(3), 257-25

Appendix A

Cover letter

11/5/93

Dear _____,

I am a graduate student at San Jose State University and this paper on resistance training during pregnancy is a part of my thesis project. It is directed toward those in the health care field that may be advising women on this topic. You have been asked to evaluate this paper due to your experience and due to the likelihood that you will be asked for advice on resistance training during pregnancy.

Please review this paper and answer the questions as directly as possible. When you have completed the questionnaire please return it to me by 11/22/93.

Thank you very much for your interest, your responses are valued highly.

Sincerely,

Donna Waugh

Appendix B
Questionnaire

**Evaluative Questionnaire for
Resistance Training During Pregnancy: A critique of present
recommendations**

Respond to the following statements as directly as possible. Circle the comment that best represents your response to each statement (from strongly agree to strongly disagree). Please add comments that will facilitate revision of the paper.

1. I have advised pregnant women on this topic.

strongly agree agree undecided disagree strongly disagree

Comments:

2. I would advise differently after reading the paper.

strongly agree agree undecided disagree strongly disagree

Comments:

3. I had a good understanding of this topic before reading this paper.

strongly agree agree undecided disagree strongly disagree

Comments:

4. The author addressed this issue in an unbiased manner.

strongly agree agree undecided disagree strongly disagree

Comments:

5. This paper adequately covers the topics of:

5A. Past Advice

strongly agree agree undecided disagree strongly disagree

Comments:

5B. Joint Laxity

strongly agree agree undecided disagree strongly disagree

Comments:

5C. Valsalva Manuever

strongly agree agree undecided disagree strongly disagree

Comments:

5D. Supine Position

strongly agree	agree	undecided	disagree	strongly disagree
---------------------------	--------------	------------------	-----------------	------------------------------

Comments:

5E. Hyperthermia

strongly agree	agree	undecided	disagree	strongly disagree
---------------------------	--------------	------------------	-----------------	------------------------------

Comments:

5F. Fetal Blood Supply

strongly agree	agree	undecided	disagree	strongly disagree
---------------------------	--------------	------------------	-----------------	------------------------------

Comments:

5G. Weight Limitations

strongly agree	agree	undecided	disagree	strongly disagree
---------------------------	--------------	------------------	-----------------	------------------------------

Comments:

5H. Free Weights vs Machines.

strongly agree agree undecided disagree strongly disagree

Comments:

5I. Experienced vs Non-Experienced

strongly agree agree undecided disagree strongly disagree

Comments:

5J. Benefits of Resistance Training During Pregnancy

strongly agree agree undecided disagree strongly disagree

Comments:

6. I have a better understanding of this topic after reading this paper.

strongly agree agree undecided disagree strongly disagree

Comments:

7. The paper is written in a clear and concise manner.

strongly agree agree undecided disagree strongly disagree

Comments:

8. Is there any other information that you believe should be included in this paper?

9. Is there any part of this paper you feel should be omitted? Why?

Your time and effort, as well as your comments are greatly appreciated.
Please return the questionnaire to me by 11/20/93

Thank You,

Donna Waugh

Send to: Donna Waugh
P O Box 1465
Soquel, CA 95073