Aquatic-Aerobic Exercise as a Means of Stress Reduction during Pregnancy

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Abstract

The goals of this research were to explore the current literature regarding associations between psychological stress and adverse fetal outcome, associations between aerobic exercise and psychological stress reduction, and associations between aerobic exercise and fetal outcome. The published studies that were located provide evidence of the following: 1) Stress reactivity increases physiologically during pregnancy, 2) pregnant women may experience additional stressors that are usually not experienced in a nonpregnant state, 3) psychological stress in pregnancy is associated with adverse fetal outcome, 4) exercise can be a method of stress reduction, 5) exercise in pregnancy is not associated with adverse fetal outcome, and 6) exercise in pregnancy may provide benefit to the fetus. Data were analyzed from an original study and associations were reported between psychological stress-management activities and participation in aquatic aerobic exercise classes. No reports were available investigating an exercise-induced reduction in psychological stress with fetal outcome.

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Adverse pregnancy outcome is a significant health concern. One goal of the United States' national strategy is to reduce the incidence of low birth weight infants to no greater than 5% of live births, from 7.6% in 1998. The goal for reducing preterm birth is to reduce the percentage from 11.6% (1998) to 7.6% in 2010 (U.S. Department of Health and Human Services, 2000). The rates of these adverse outcomes of pregnancy remain considerably high despite extensive use of perinatal tech-

nologies and screening methods. Thus, the scientific community's interest in psychological risk factors during pregnancy has increased (Austin and Leader, 2000; Rini, Dunkel-Schetter, Wadhwa, & Sandman, 1999).

Psychological stress as a contributor to adverse fetal outcome has been addressed by several studies over the past decade. The majority of these studies reported that a high level of maternal stress is associated with adverse fetal outcome. Given these findings, it can logically be hypothesized that reducing maternal stress may improve fetal outcome.

The stress-reduction method of interest in this research is aerobic exercise. Many forms of aerobic exercise in pregnancy have been supported as safe and beneficial to health. However, few studies have focused on the psychological stress-reduction benefits of aerobic exercise in pregnancy or linked such benefits to improved fetal outcome.

Literature Review Process

Three topics were thoroughly reviewed: 1) psychological stress and pregnancy with a focus on fetal outcome, 2) aerobic exercise and stress reduction in a general population, and 3) aerobic exercise and pregnancy. A limit was set to include articles from the past decade, 1991 to the

present, thus ensuring timely information. Other inclusion criteria were the use of human subjects, female participants, and original research and meta-analyses. Studies addressing stress other than psychological stress were excluded.

In studies addressing fetal outcome, only prospective studies were included to eliminate the possibility of recall bias in cases of adverse pregnancy outcome. Three retrospective studies were located, but excluded. Also excluded were reports on preterm *labor* with no mention of *birth*. Research on preterm labor was not considered an adverse fetal outcome and was distinguished from preterm birth, which is more clearly an adverse fetal outcome. The Table presents a synopsis of the research studies reviewed.

Review of Literature

Psychological Stress and Associated Physiology

The effects of psychological stress on physical body functioning in general has been widely studied. Most studies suggest a negative association (Austin and Leader, 2000). Psychological stress is "the result produced when a structure, system, or organism is acted on by forces that disrupt equilibrium or produce strain When stress

Table Outcomes of Studies Reviewed

Author and Date	Sample Size	Study Design	Study Focus	Outcomes/Themes
Bungum, Pealsee, Jackson, & Perez (2000)	137 pregnant women	Nonexperimental	Association between aerobic exercise and cesarean section rate	Exercising may be associated with reduced cesarean section rates.
Carmack, Boudreaux, Amaral-Melendez, Brantley, & Moor (1999)	135 men and women	Nonexperimental	Relationships between stress and leisure physical activity versus fitness level	Leisure physical activity is more significantly associated with reduced stress.
Clapp, Kim, Burciu, & Lopez (2000)	46 pregnant women	Nonexperimental	Association between regular exercise and fetoplacental growth	Weight-bearing exercise enhances fetoplacental growth.
Copper et al. (1996)	2,593 pregnant women	Nonexperimental	Associations between poor psychosocial status and preterm birth, low birth weight, growth restriction	Stress was significantly associated with low birth weight and preterm birth.
DaCosta, Larouche, Dritsa, & Brender (1999)	161 pregnant women	Nonexperimental	Identifying pregnancy-specific stress and state anxiety in pregnancy	Found pregnancy-specific factors associated with increased stress, such as effects on career, marital adjustment, and others.

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Table Outcomes of Studies Reviewed (*continued*)

Author and Date	Sample Size	Study Design	Study Focus	Outcomes/Themes
Hassemen, Koivula, & Uutela (2000)	3,403 men and women	Nonexperimental	Association between physical activity and perceived stress	Physically active participants reported less perceived stress.
Hatch et al. (1993)	876 pregnant women	Nonexperimental	Associations between exercise participation and infant birth weight	Regular maternal exercise participation was associated with heavier infant birth weights.
Hatch, Levin, Shu, & Susser (1998)	876 pregnant women	Nonexperimental	Maternal exercise and risk of preterm birth	Maternal exercise was associated with reduced risk of preterm birth.
Hedegaard, Henriksen, Sabroe, & Secher (1993)	5,872 pregnant women	Nonexperimental	Associations between maternal stress and risk of preterm delivery	Positive "dose-response" was found between maternal stress and preterm delivery.
Hobel, Dunkel-Schetter, Roesch, Castro, & Arora (1999)	524 pregnant women	Nonexperimental	Association between elevated maternal CRH levels and preterm birth	Higher CRH and ACTH levels associated with preterm delivery.
Horns, Ratcliffe, Leggett, & Swanson (1996)	101 pregnant women	Nonexperimental	Associations between maternal third trimester exercise and infant birth weight, gestational length, weight gain, and discomforts	No significant differences were found between the exercise group and the sedentary group.
Kardel & Kase (1998)	42 pregnant women	Nonexperimental	Maternal exercise and fetal onset of labor, birth weight, APGAR score	All APGAR scores and birth weights were normal; no premature deliveries.
Lobel, DeVincent, Kaminer, & Meyer (2000)	129 pregnant women	Nonexperimental	Association between maternal stress and infant birth weight	No association was found.
Lobel, Dunkel-Schetter, & Scrimshaw (1992)	130 pregnant women	Nonexperimental	Associations between maternal stress and gestational length and birth weight	Maternal stress was positively associated with decreased birth weight and shorter gestational length.
Lokey, Tran, Wells, Myers, & Tran (1991)	2,314 pregnant women, 18 studies	Meta-analysis	Differences in maternal weight gain, gestational length, duration of labor, infant birth weight, and APGAR scores between exercisers and nonexercisers	No significant differences were found between exercisers and nonexercisers in any of the listed outcomes.
Lox & Treasure (2000)	41 pregnant women	Nonexperimental	Association between exercise participation and psychological distress	Aquatic exercise may reduce psychological stress in pregnancy.
Mock et al. (1997)	46 women diagnosed with breast cancer	Experimental	Effect of participation in a walking program on physical functioning, fatigue, distress	Fatigue and emotional distress decreased in the exercise groups.
Petraglia et al. (2001)	382 pregnant women	Nonexperimental	Association between maternal CRH and cortisol levels and measured psychosocial stress	No significant difference was found in serum CRH levels between high- and low-stress groups.
Rajeski, Thompson, Brubaker, & Miller (1992)	48 women	Quasi-experimental	Effects of aerobic exercise sessions on blood pressure responses to psychosocial stress	Aerobic exercise sessions lower blood pressure responses to psychosocial stress.

Table Outcomes of Studies Reviewed (*continued*)

Author and Date	Sample Size	Study Design	Study Focus	Outcomes/Themes
Rini, Dunkel-Schetter, Wadhwa, & Sandman (1999)	230 pregnant women	Nonexperimental	Associations between stress, infant birth weight (IBW), and preterm delivery (PTD)	State anxiety and pregnancy-related anxiety associated with PTD and not associated with IBW.
Skirka (2000)	135 women 135 men	Nonexperimental	Relationship between sports participation and perceived stress	Athletes reported significantly less stress than nonathletes.
Steptoe, Kimbell, & Basford (1998)	38 men 35 women	Qualitative	Exercise participation and daily inventory of stress	Reported daily stressors decreased with exercise participation in the low-anxiety group.
Wadhwa, Porto, Garite, Chic-DeMet, & Sandman (1998)	63 pregnant women	Nonexperimental	Relationships between maternal CRH levels and gestational length	Elevated maternal plasma CRH was associated with preterm birth/shorter gestational length.
Wadhwa, Sandman, Porto, Dunkel-Schetter, & Garite (1993)	90 pregnant women	Nonexperimental	Associations between maternal stress and birth outcome	Maternal stress was positively associated with decreased birth weight and shorter gestational length.
Yali & Lobel (1999)	167 pregnant women	Nonexperimental	Coping with high-risk pregnancy, pregnancy-specific distress	Pregnant women expressed stress regarding pregnancy-specific issues.

occurs in quantities that the system cannot handle, it produces pathological changes” (Thomas, 1997, p. 1845). Even in that definition of stress, it is apparent that overwhelming stress is believed to produce damaging effects on human beings. Chrousos and Gold (1992) described the concept of stress in terms of adaptation to environment. Human beings attempt to maintain physiological and psychological equilibrium in order to survive. These authors further explained that the equilibrium is challenged by intrinsic or extrinsic stressors that, if chronic, lead to adverse health outcomes. This description of stress also suggests undesirable effects on human beings.

Understanding the physiologic mechanism of the stress response is essential to understanding how stress can harm the human body. The stress response is defensive in nature and intended for survival. The basic mechanism of the stress response lies within the hypothalamic-pituitary-adrenal axis (HPA) and the autonomic nervous system (ANS), which respond to acute and chronic stress, as well as the anticipation of stress (Lederman, 1995). The HPA regulates the stress response through a cortico-

tropin-releasing hormone (CRH), which stimulates the release of β -endorphins and adrenocorticotrophic hormone (ACTH); ACTH stimulates the adrenal cortex to release cortisol (Lederman, 1995). The ANS regulates the release of catecholamines (norepinephrine and epinephrine) from the adrenal medulla (Lederman, 1995).

It is important to note that the physiologic stress response is augmented during pregnancy. In addition to nonpregnant stress-response mechanisms, the placenta also produces CRH beginning in the second trimester, followed by an exponential increase in circulating CRH that occurs in the last two to four weeks of pregnancy (Hobel, Dunkel-Schetter, Roesch, Castro, & Arora, 1999; Lederman, 1995). “Placental CRH is identical to hypothalamic CRH in structure, immunoreactivity, and bioactivity” (Wadhwa, Porto, Garite, Chic-DeMet, & Sandman, 1998, p.1079). Therefore, the pregnant body is naturally at a heightened state of potential stress reactivity (Sandman, Wadhwa, Chic-DeMet, Dunkel-Schetter, & Porto, 1997; Wadhwa et al., 1998) and, thus, vulnerable to a state of stress overload.

Not only is stress reactivity augmented physiologically

during pregnancy, but pregnant women may also experience additional stressors that are not usually present in a nonpregnant state. Wadhwa, Sandman, Porto, Dunkel-Schetter, and Garite (1993) measured episodic and chronic stress, strain, and pregnancy-related anxiety and reported a higher level of stress in their sample of pregnant women compared to published averages in community-based adult samples. One explanation is that pregnancy is a major life event and often requires a stressful period of adjustment for the expectant mother and the rest of the family. DaCosta, Larouche, Dritsa, and Brender (1999) reported that concerns about marital adjustment, career issues, gestational complication, and younger age were all associated with increased stress through all three trimesters in a prospective study of 161 pregnant women. Other pregnancy-specific stressors included concern about physical symptoms, the birth of the baby, the health of the baby, and potential preterm birth (Yali & Lobel, 1999). Ludman and colleagues (2000) found additional stressors in that younger age, lower income, single marital status, and reported unintended pregnancy were factors most strongly associated with higher psychological stress in pregnancy and depressive symptoms.

Psychological Stress and Adverse Fetal Outcome

Two studies have linked the *biological stress indicators* of elevated ACTH and cortisol levels to adverse fetal outcome, particularly spontaneous preterm delivery (SPD; delivery before 37 weeks gestation). Hobel and colleagues (1999) prospectively followed 524 women and ultimately matched 18 cases of preterm birth against 18 matched control cases of term deliveries. The two groups were matched according to gestational ages, demographic data, and medical and obstetric history. The plasma CRH levels were analyzed for all 524 women at three different gestational ages: 18–20, 28–30, and 35–36 weeks before the outcomes were known. Women who delivered preterm had higher plasma CRH and ACTH levels at all three gestational ages than the matched control group with a significance level ($p < 0.0001$). Similarly, Wadhwa and colleagues (1998) reported that elevated CRH is associated with preterm birth in a prospective study of 63 adult women with singleton pregnancies. The experimenters collected plasma samples between 28 and 30 weeks gestation. The

association between elevated CRH and preterm birth was significant ($p < 0.01$) and independent of antepartum risk and parity. In summary, both of these studies found a significant association between elevated CRH and preterm delivery. On the other hand, Petraglia and colleagues (2001) found no significant difference in CRH levels between high- and low-stress groups in a prospective study. This study included a population of 382 Caucasian pregnant women, only 119 of whom completed the serum CRH testing at 28 weeks gestation.

Much of the research on *perceived psychological stress* in pregnancy also suggests an association with adverse fetal outcome. Infant birth weight and SPD are the most commonly studied preterm birth variables. Low birth weight (LBW) is defined as weight less than 2500 grams at delivery. LBW and SPD are associated with increased fetal morbidity and mortality and are the most prevalent adverse fetal outcomes (U.S. Department of Health and Human Services, 2000).

Lobel, Dunkel-Schetter, and Scrimshaw (1992) prospectively studied 130 mostly Latino and African-American women attending a public prenatal clinic. Data were collected at five different prenatal interviews and one postpartum interview for each participant. The authors reported that women experiencing higher prenatal psychological stress gave birth to infants that weighed less ($p < 0.01$), no matter what the gestational age at delivery and independent of medical risk factors. They also found evidence that prenatal stress has a negative impact on gestational age of delivery independent of parity and medical risk factors ($p < 0.03$). In contrast, Lobel, De-Vincent, Kaminer, and Meyer (2000) found no evidence that prenatal maternal stress affected birth outcomes in a study of 129 mostly married, Caucasian, high-risk obstetric patients. Both studies included multiple testing times and the sample sizes were equivalent, but the samples consisted of very different populations. One explanation suggested by Lobel and colleagues (2000) was that the participants included in their study might have been less vulnerable to the stress experienced by an economically disadvantaged sample.

Wadhwa and colleagues (1993) prospectively studied 90 pregnant adult women (77% Caucasian). Chronic stress, strain, and pregnancy-related anxiety were measured at 18, 28, and 36 weeks gestation. The authors reported a direct relationship between increased stress from prenatal life events and lower infant birth weight.

The authors also reported a direct relationship between earlier gestational age at birth and higher pregnancy-related anxiety, specifically fear and anxiety related to labor and delivery and the health of the infant. Furthermore, the authors reported prevalence odds ratios for both findings ($p < 0.05$): "Each unit increase of prenatal life event stress (from a possible sample range of 14.7 units) was associated with a 55.03 gm decrease in infant birth weight and with a significant increase in the likelihood of low birth weight (odds ratio 1.32) and, similarly, each unit increase of prenatal pregnancy anxiety (from a possible sample range of 5 units) was associated with a 3-day decrease in gestational age at birth" (Wadhwa et al., 1993, p. 864).

Some of the same authors, Rini and colleagues (1999), reported on a similar prospective study of a low-income group of 120 Hispanic and 110 Caucasian pregnant, adult women to observe associations between prenatal psychosocial stress, personal resources, sociocultural factors, and infant birth weight and gestational age at delivery. They found that both state anxiety and pregnancy-related anxiety were negatively associated with gestational age at delivery ($\beta = -0.20$), but not with birth weight. This finding is similar to the previous study in that pregnancy-related anxiety is associated with gestational age at delivery. It is different in that there was no association with birth weight. The authors reported that the following were associated with lower stress: Caucasian race, marriage, higher income, higher education, and primiparous status. Thus, the authors reported a significant indirect effect of resources mediated by demographic stress-reduction factors on gestational age at delivery ($\beta = 0.13$, $p < 0.05$).

Copper and colleagues (1996) prospectively studied 2,593 pregnant women among 10 different sites to discover which aspects of psychosocial status are associated with preterm birth and low birth weight. They found that perceived stress was the only psychosocial factor associated with both LBW and spontaneous preterm birth after controlling for maternal demographic and behavioral characteristics. The authors reported a prevalence odds ratio of 1.6 for preterm birth with each one-point increase on the perceived stress scale ($p = 0.003$). Likewise, Hedegaard, Henriksen, Sabroe, and Secher (1993) reported relative risks of 1.31 and 1.92 for preterm birth in their moderate- and high-stress categories, respectively ($p < 0.05$). These categories were cre-

ated to facilitate data organization. Each participant's ($N = 5872$) placement in "moderate-stress" or "high-stress" was based on her questionnaire score. The authors reported a "dose-response relation" (p. 237) according to these relative risk values. One difference between the studies was that Hedegaard and colleagues (1993) collected data at 16 and 30 weeks gestation using a general health questionnaire that was not pregnancy-specific, while Copper and colleagues (1996) used a pregnancy-specific instrument and evaluated the participants during four different visits during the pregnancy. However, these two study designs were similar in several ways and yielded comparable data.

These studies provide consistent evidence that prenatal maternal psychological stress is a contributor to adverse fetal outcome, especially when stress-reducing demographic factors are controlled. Strong evidence exists in support of contribution to low birth weight and preterm delivery, in particular. A logical next step is to explore methods of stress reduction that may help to reduce the prevalence of these adverse outcomes.

Exercise and Psychological Stress Reduction in the General Population

Exercise has generally been shown to be associated with stress reduction. Psychological benefits of exercise that have been reported include reduced depression, anger, perceived stress, and anxiety as well as increased perceived health and fitness (Hasseman, Koivula, & Uutela, 2000). The majority of studies include male and non-pregnant female participants.

Carmack, Boudreaux, Amaral-Melendez, Brantley, and Moor (1999), Skirka (2000), and Hasseman and colleagues (2000) all found an association between some form of aerobic exercise and lower levels of stress in their survey studies. Skirka (2000) surveyed two groups of college students: 135 college varsity athletes and 135 nonathletes (defined as exercising no more than twice a week). The author reported that participants of varsity teams who presumably engaged in frequent aerobic exercise had significantly less perceived stress and psychological symptoms than the nonathletes ($p < 0.05$). Furthermore, no significant differences existed in perceived stress between males and females on the teams. In contrast, Carmack and colleagues (1999) surveyed a different group of college students ($N = 135$) and suggested

that protection against stress is greater with a larger amount of time spent in leisure physical activity ($p < 0.05$) as opposed to aerobic fitness level. Hassemien and colleagues (2000) also studied perceived stress in a design similar to these two studies, but surveyed a much larger cross-sectional sample of men and women ages 25 to 64 years ($N = 3403$). The authors reported that physically active subjects reported less perceived stress than less active subjects ($p < 0.01$). Because a college-aged group is weighted towards 18- to 25-year-olds, the results of these three observational studies may be applicable to a population of young women of childbearing age.

Two experimental design studies produced additional data that support a stress-buffering effect of exercise. Rejeski, Thompson, Brubaker, and Miller (1992) studied 48 women, aged 25-40 years with low to moderate levels of fitness, in a quasi-experimental design focusing on physiologic response to stress. Frequency and intensity of stressors were measured using a physiologic measure of blood pressure and the Multiple Affect Adjective Check List—Revised (Zukerman & Lubin, 1985). Intensity of anxiety was rated according to scores on the anxiety-related items and categorized into low, moderate, or high anxiety. The authors reported that an episode of aerobic exercise reduced the blood pressure reactivity to stressors produced in the laboratory and reduced the frequency and intensity of anxiety ($p < 0.01$). They ultimately suggest a stress-buffering effect of exercise that varies with the intensity of the stressor.

In a different study focusing on another example of life-event stress, Mock and colleagues (1997) conducted an experimental study of 46 women undergoing radiation therapy for breast cancer who were not participating in any type of exercise. The subjects were randomly assigned to either the nonexercise group or the exercise group, which participated in a structured walking program for six weeks. Among several physical and psychological benefits, the exercise group reported decreased emotional distress. Emotional distress remained elevated in the nonexercising group. These findings were significant at a level of $p < 0.001$. Both of these experimental design studies contribute statistically significant evidence that exercise potentially reduces psychological stress.

One study we found focused on daily appraisal of stress. Steptoe, Kimbell, and Basford (1998) conducted an observational study to examine exercise and the perception of daily stressors in a sample of 38 men and 35

women. The exercise group consisted of participants who exercised one to four times a week. Each participant recorded his/her thoughts in a diary provided by the experimenters. The diary contained a blank diary page, six items from the Profile of Mood States (McNair, Lorr, & Droppleman, 1981) and a page of 25 items from the Daily Stress Inventory (Brantley & Jones, 1989) for each of the 12 consecutive days. The authors reported that the number of events perceived as stressful was consistently less on exercise days than nonexercise days in those subjects who had been categorized as low-trait anxiety ($p < 0.025$) or for those who had personal motives for exercise ($p < 0.005$).

In summary, all of these studies support some psychological benefit of exercise in groups of nonpregnant women.

Exercise and Stress Response in Pregnant Women

Only one study that included pregnant participants was found on the topic of stress response and exercise. Lox and Treasure (2000) conducted a study of 41 middle- and upper-income, mostly Caucasian, pregnant women to observe the effects of exercise participation on feeling states. All 41 subjects participated in prenatal aquatics exercise classes that were offered twice a week for six weeks, each session lasting 45 minutes. The experimenters administered the Subjective Exercise Experiences Scale (McAuley & Courney, 1994) before and after the six-week session to assess feeling states. The instrument was also administered at four different exercise sessions, before and after the session. Participants reported less psychological distress at completion of the aquatic exercise program and also following single sessions of aquatic exercise (all differences were significant at $p < 0.0001$). This study provides consistent evidence that aerobic exercise may reduce psychological stress in pregnant women. However, a control group was not included for comparison and fetal outcome was not mentioned in the report.

Regular Maternal Aerobic Exercise and Fetal Outcome

Each study found and discussed in this section provides evidence that exercise during pregnancy does not harm the fetuses of healthy mothers. Furthermore, some of the authors suggest that exercise may actually benefit

the mother and the fetus. Exercise is an important part of many women's lives. Based on advice previously given to their mothers or grandmothers, women may believe that they must discontinue exercise habits during pregnancy due to a fear of harming the fetus. Present recommendations support that healthy women without medical or obstetric complications can continue to exercise during pregnancy, but they may have to adapt their routines to accommodate physiologic changes of pregnancy (American College of Obstetricians and Gynecologists [ACOG], 2002). ACOG based its guidelines on the results of research.

Lokey, Tran, Wells, Myers, and Tran (1991) conducted a meta-analysis including 18 different studies, totaling 2314 subjects, to observe the effects of physical exercise on pregnancy outcomes. All published original research before 1990 addressing exercise training in pregnancy and fetal outcome was included. No report existed on the design of the individual studies. Eleven of the studies included control groups, representing 957 of the participants. Some of the variables included were age, height, gestation length, body weight gain, body weight, length of labor, infant birth weight, and APGAR score. The authors reported that the outcome variables did not vary significantly among the studies. The authors concluded that no significant differences appeared in gestational age at birth, infant birth weight, and APGAR scores between groups of exercising women and nonexercising women. Thus, the 18 studies published before 1990 collectively provided statistically significant evidence that exercise during pregnancy does not harm the fetus. However, no evidence demonstrated that exercise benefited the fetus.

Two subsequent prospective studies performed in the 1990s brought about similar findings to those included in the meta-analysis conducted by Lokey and colleagues (1991). Horns, Ratcliffe, Leggett, and Swanson (1996) recruited 101 primiparous women with no medical complications. Forty-eight inactive participants were recruited into the sedentary group. Fifty-three active participants were recruited into the active group. The authors found no significant differences in infant birth weight, APGAR scores, and gestational age at birth between the two groups. Using a different type of subject, Kardel and Kase (1998) recruited well-trained, regular exercisers ($N=42$) and followed them from less than 20 weeks gestation through the rest of the pregnancy. All

infants were term and weighed above 3000 grams at birth, well within normal limits. They also all had normal APGAR scores at one- and five-minutes postdelivery. These two studies of different populations reached the similar conclusions that regular exercisers did not give birth to infants at an earlier gestational age or lower birth weight and that APGAR scores were not negatively affected by exercise. Again, no benefits to the fetus were demonstrated in these two studies.

Bungum, Pealsee, Jackson, and Perez (2000) reported a study that suggested the benefit of exercise to the mother and infant. They also found no significant difference in fetal birth weight or length of gestation between a group of nonexercisers ($N=93$) and a group of women who exercised for 20 minutes at least three times a week ($N=44$). However, the authors also suggested that exercise does benefit both the fetus and mother by reducing the rate of cesarean birth. In their group of regular exercisers, 84% gave birth vaginally and 16% by cesarean birth. In their group of nonexercisers, 72% gave birth vaginally and 28% experienced cesarean birth. The authors reported an odds ratio for cesarean birth of 4.48 for sedentary women in comparison to active women ($p=0.023$). Cesarean birth is associated with risks such as infection, hemorrhage, reduced bowel motility, longer recovery, and respiratory complications (Gilbert & Harmon, 1998). Therefore, avoiding cesarean birth is a benefit to both mother and infant based on these stated risks.

Several other studies provided evidence that prenatal exercise actually provides benefit to the infant. Clapp, Kim, Burciu, and Lopez (2000) randomly assigned 46 women to a weight-bearing exercise group or no exercise group to test their hypothesis that beginning exercise in pregnancy would not affect fetal growth. The exercisers performed aerobic exercise activities at moderate-intensity three to five times every week throughout their pregnancies. The offspring of these women were significantly heavier than the offspring of the nonexercisers by an average of 0.25 kg ($p<0.05$). The authors concluded that moderate-intensity, weight-bearing exercise is associated with a significant increase in fetal birth weight. In a similar but larger prospective study, Hatch and colleagues (1993) recruited 876 participants and also found that exercise was positively and significantly associated with infant birth weight. Participants were interviewed at initiation of prenatal care, 28 weeks, and 36 weeks gestation. Low-moderate exercisers (expending <1000

calories/week) gave birth to infants weighing approximately 100 grams more than those of nonexercisers ($p < 0.05$). Heavy exercisers (expending >1000 calories/week) gave birth to infants weighing approximately 276 grams more than those of nonexercisers ($p < 0.05$). In another analysis of the same sample, Hatch, Levin, Shu, and Susser (1998) observed that, whereas no difference in gestational age at delivery existed between the nonexercise group and the low-moderate exercise group, the heavy exerciser group showed a significant reduction in the risk of spontaneous preterm birth. For instance, at 36 weeks gestation, heavy exercisers had a relative lower risk of 0.11 (95% CI = 0.02, 0.81) for preterm birth. These three studies provide additional evidence that exercise during pregnancy may actually benefit the fetus.

A Pilot Study of Aquatic Aerobics in Pregnancy

The authors of this paper collected original data in a quasi-experimental pilot study of six nonexercisers and nine exercisers who participated in a six-week prenatal aquatic aerobics class. The original study was conducted as a pilot for future research to explore the effects of aquatic aerobics on the discomforts of pregnancy. However, in addition to discomforts data collected during recruitment, the participants had the opportunity to self-select into either an exercising or nonexercising group. The sample mean age was 28.9 years with a range of 19–36 years. Additionally, 75% were Caucasian and 25% African-American. Both groups completed the Health Promotion Lifestyle Profile (HPLP) developed by Walker, Saghris, and Pender (1987) before and after the six-week exercise sessions. The HPLP instrument contains six subscales, including a stress-management subscale that addresses the degree of stress and use of stress-relief methods by the participant. Walker and colleagues (1987) reported a reliability of 0.793 for this stress-management subscale. Statistical Package for Social Sciences (SPSS) was the computerized statistical program used to analyze the data. The objective of this analysis was to explore differences in reported stress-management behaviors between the two groups at times one (pretest) and two (post-test).

To determine similarity or difference between the groups at time one, an independent t-test was run on the pretest data from the stress-management subscale. It showed no differences in stress management between

the exercising and nonexercising group at a significance level of 0.403. The post-test was administered six weeks after the pretest. Analysis of covariance tests was conducted. The subjects who had participated in the aquatic aerobics intervention reported a higher level of participation in health promoting stress-management activities at post-test than the nonexercising group at a significance level of 0.009. Assuming such activities do reduce perceived stress, it could logically be hypothesized that aquatic aerobic exercise has the potential to play a role in reducing the level of psychological stress in pregnancy. The reliability of the HPLP scale obtained from this sample was 0.711, indicating good reliability. At the conclusion of the exercise intervention, the exercising group reported feeling less psychologically stressed.

Discussion

The studies included in this review of literature provide evidence of the following: 1) Stress reactivity increases physiologically during pregnancy, 2) pregnant women may experience additional stressors that are usually not experienced in a nonpregnant state, 3) a higher level of maternal psychological stress is associated with adverse fetal outcome, 4) exercise can generally provide psychological stress reduction, 5) exercise in pregnancy has not been shown to be associated with adverse fetal outcomes, and 6) exercise in pregnancy may provide some benefit to the fetus. Most authors found that birth weight is negatively affected by high psychological stress, and all but one group reported an association with preterm birth. The majority of these studies reported data statistically significant at a level of $p < 0.05$ or better, and most of the sample populations consisted of more than 100 participants. The studies addressing the topic of exercise and fetal outcome were also similar and consistent in results.

The evidence that aerobic exercise reduces stress in the general population is relatively strong and provides reason to hypothesize that it would do the same for pregnant women. Only one published study was found that addressed this topic and included pregnant participants (Lox and Treasure 2000). The secondary data analysis from the pilot study reported here also showed a positive relationship between exercise participation and reduction in stress-management activities.

Suggestions for Further Research

Upon reviewing the current literature on the topics of interest, several suggestions for future research can be made. Although the literature clearly shows that increased psychological stress is associated with adverse fetal outcome, no evidence was found on fetal outcome associated with an intervention of psychological stress reduction. However, enough evidence is presented here to suggest further research of this nature. In order to design a study with this purpose, a distinction between the effects of exercise and the effects of reduced stress must be made. The studies reviewed here provide evidence that psychological stress increases prevalence of adverse fetal outcome and that exercise decreases the prevalence of some types of adverse fetal outcomes. Therefore, exercise may have both a direct and an indirect role in reducing the prevalence of adverse fetal outcome—the indirect role being that exercise may reduce psychological stress and, thus, reduce adverse fetal outcome.

When studying adverse fetal outcome, prospective studies are important so that recall bias can be eliminated. Mothers of fetuses with poor outcome may be more likely to retrospectively recall negative situations if they are looking for a reason for the loss, thus increasing the potential for recall bias. An adequately large sample is necessary to ensure a number of cases of anticipated adverse outcome to be able to document a measurable difference. Further, because stress experiences are not stable in life-multiples measurement, times of testing are recommended. In a hypothetical situation, if a sample of pregnant women is surveyed for stress level at 20 and 30 weeks, a very stressful situation could occur between weeks 30 and 40. Such a situation could severely skew the postbirth data, especially in a smaller sample. Furthermore, multiple testing times may allow the experimenter to distinguish between long-term and short-term stress.

Studies that rely on participant self-report of exercise activity are less reliable than experimental and quasi-experimental studies in which the experimenter has some direct observation of the participant's activity level. Thus, it is recommended that the design arrange for this. Furthermore, it is possible that stress must initially exist at a relatively high level to be able to observe a significant decrease in stress. If a low-stress population is recruited,

the potential intervention effects may not be demonstrated. Furthermore, given the reported observation of a possible effect of socioeconomic status on stress levels, the use of a diverse sample may provide an opportunity to hold this variable constant.

In conclusion, more research is needed to further explore the associations between aerobic exercise and psychological stress in the general population, as well as in pregnancy.

Conclusions and Implications for Childbirth Education

The information provided here is applicable to both nursing practice and childbirth education. For decades, stress-reduction strategies have been an important aspect of childbirth education. Such strategies can be continued with confidence and addressed without waiting for definitive research on its role in maternal and fetal outcomes. Clearly, none of the research reviewed suggested that continued work in stress management strategies is problematic. The childbirth educator's role in introducing stress management to the expectant family is one of both communicator and facilitator. As a facilitator, the childbirth educator cognizant of stress-reducing strategies can continue to teach relaxation techniques for birth and pregnancy, as well as advise the expectant family of community resources. As communicators, childbirth educators are encouraged to assess and listen to their clients. It cannot be assumed that pregnancy is stress-free for a woman, even if she appears to be generally positive about being pregnant. All health care providers must be aware that any pregnant woman may be experiencing high levels of stress. Childbirth educators can become alert to recognizing pregnant women who may be at higher risk for increased psychological stress, such as women with an unintended pregnancy (Ludman et al., 2000).

During preconception and prenatal education, devoting attention to psychological needs of the client and discussing methods of relaxation and stress reduction are two ways that childbirth educators can help women lower their stress levels. One method to augment relaxation may be participation in an aerobic exercise program, such as prenatal aquatic aerobics or, if appropriate, a physical activity that couples can participate in together. Although exercise and stress-reduction

techniques to promote a good birth experience were the original focus of childbirth education, evidence is accumulating that these same techniques may also promote a healthy pregnancy.

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Heideggerian Hermeneutic Phenomenology

Martin Heidegger (1927–1962) believed that people are situated in the world and that all understanding of the world occurs through experiences. While engaged in the world, one grasps meanings and becomes a self-interpreting being.

Researching lived experience within Heideggerian philosophy is an act of interpretation of the transcribed text, known as *hermeneutics*, whereby the shared meanings of the text and the researcher become explicit (Gadamer, 1990). The goal of hermeneutics is “discovery of meaning that is not immediately manifest to our intuiting, analyzing, and describing” (Cohen & Omery, 1994, p. 146). The researcher must go beyond what is directly given in the narrative to look for the clues in the hidden meanings in the everyday experiences. Additionally, critical hermeneutics calls one to go beyond the most obvious interpretation and to keep a suspicious attitude in looking for meanings (Thompson, 1990).

Note: This box provides additional information for the article *Woman-Centered Maternity Nursing Education and Practice* found on pp. 18–28.