

Influence of prenatal physical activity on the course of labour and delivery according to the new Polish standard for perinatal care

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Szumilewicz A, Wojtyła A, Zarębska A, Drobnik-Kozakiewicz I, Sawczyn M, Kwitniewska A. Influence of prenatal physical activity on the course of labour and delivery according to the new Polish standard for perinatal care. *Ann Agric Environ Med.* 2013; 20(2): 380–389.

Abstract

Introduction. Prenatal physical activity has been increasingly recommended in recent years as the fundamental condition of physiological pregnancy and birth by health promoting organizations throughout the world.

Objective. To determine the influence of prenatal physical activity on the course of labour and delivery. The practical purpose was to present prenatal physical activity as an effective tool in the implementation of the new Polish standard for perinatal care.

Brief description of the state of knowledge. Reviewed publications report either a positive impact or no impact of physical activity on selected parameters of labour and delivery. The most frequently cited benefits of physical exercise during pregnancy include: shorter delivery, less frequent need for anesthesia, reduced risk of operative births, a lower rate of induction of labor, amniotomy, episiotomy and perineum lacerations, and improved neonatal outcome.

Conclusions. A review of the literature shows that regular prenatal physical activity can help reduce medical interventions during labour, without having negative consequences for either the mother or the foetus. It should be an important tool to implement the Polish standard for perinatal care. There is a need to promote regular prenatal physical activity among women, medical personnel, and physical education staff. Detailed instructions for designing prenatal exercise programmes should be included in the new guidelines for physical activity during pregnancy, both in Poland and abroad. To support or negate the hypothesis of the positive effects of physical activity on the course of labour and delivery, well-designed research trials should be conducted with the properly structured prenatal exercise programmes in the intervention groups.

Key words

physical activity, pregnancy, labor and delivery

INTRODUCTION

Natural birth, i.e. a birth without any medical intervention, is the best conclusion of the pregnancy for the mother and the baby, both from the psychophysical and the social point of view [1, 2]. Methods of childbirth other than physiological should be used only when justified by the circumstances [3, 4, 5]. Preparation for natural birth is worth treating as the main goal of the pregnancy for the future mothers, their families and the health care system that supports them.

Prenatal physical activity has been increasingly recommended in recent years as the fundamental condition of physiological pregnancy and birth by health promoting organizations throughout the world. In the United States, there are currently three different guidelines for prenatal physical activity. While these recommendations may appear similar, subtle discrepancies exist in the language. The American College of Obstetrics and Gynecology (ACOG) currently recommends that pregnant women accumulate 30 minutes or more of moderate-intensity exercise on most, if not all, days of the week, if no medical or obstetric complications are present [6]. Recommendations set forth by

the US Department of Health and Human Services (DHHS) in the 2008 Physical Activity Guidelines for Americans state that pregnant women should engage in a minimum of 150 minutes of moderate-intensity aerobic activity a week, even if not physically active prior to pregnancy [7]. The American College of Sports Medicine (ACSM) currently recommends a minimum of 3 exercise sessions completed in at least 15 minute sessions, gradually increasing to 30 minutes per day, preferably all days of the week [8]. Recreational and competitive athletes may train safely at higher intensities and volumes throughout pregnancy with the understanding that they are undergoing closer obstetric supervision. Recommendations are similar in Australia [9], Canada [10], Denmark [11], United Kingdom [12] and Norway [13]. A breakthrough in the Polish obstetrics was the introduction in 2011 by the Health Ministry of new standard of perinatal care [14]. Although it lacks detailed guidelines concerning prenatal physical activity programmes, it clearly recommends using physical activity as a tool easing the birth and preventing postpartum urinary incontinence. Promoting a healthy lifestyle among women at any stage of pregnancy is recognized as one of the main activities of doctors and midwives.

Contrary to recommendations and regulations, statistics show that the great majority of pregnant women remains inactive or insufficiently active. What is more, many women limit their physical activity during pregnancy [15, 16, 17].

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Received: 20 September 2012; accepted: 27 December 2012

The medical staff do not support popularizing the physical activity of pregnant women [16], and even suggest patients reduce the intensity or frequency of physical exercise [15, 18].

In recent years, many scientific papers have been published on the impact of exercise on selected variables characterizing parturition. The most frequently cited benefits include shorter delivery [19, 20, 21, 22, 23], less frequent need for anesthesia [20, 24], reduced risk of caesarean section and operative vaginal births [20, 25, 26, 27], a lower rate of induction of labour [19, 20], amniotomy [20], episiotomy and perineum lacerations [20, 21, 28] and improved neonatal outcome directly after birth [20]. Some studies show no effect of physical activity on individual parameters of birth [29, 30, 31, 32, 33, 34, 35, 36]. To evaluate the effectiveness of prenatal exercises, there should be careful analysis of the methodology of research, the way of assessment of physical activity performed by the pregnant women, and the methodology of exercise programs offered to pregnant women in the experimental projects.

OBJECTIVE

The aim of this review study is to determine the influence of prenatal physical activity on the course of labour and delivery. The practical purpose was to present prenatal physical activity as an effective tool in the implementation of the new Polish standard for perinatal care. A systematic review of scientific papers was carried out, based on the databases: MEDLINE, Academic Search Complete, Health Source: Nursing/Academic Edition and SPORTDiscus with Full Text. The keywords used were: 'labour and delivery', 'physical activity' and 'physical exercise'. In the first round, there were no restrictions on certain years of publication. In a second round, reports published between 2007–2012 were specifically reviewed to ensure the inclusion of any

relevant new publication. The reference lists from the selected studies were also checked to identify other studies that could have been missed by electronic search. The collected data were evaluated and summarized. Because this study was not intended to be a meta-analysis, no statistical methodology was applied. An important step in the study was a detailed analysis of the new document in Polish legislation setting the standard for perinatal care [14] which was examined in terms of content related to physical activity and health promoting lifestyle. This methodology seems particularly valuable, building a bridge between medical practice and scientific achievements, linking it to implementation.

The following variables were used: the rate of labour induction, oxytocin augmentation, amniotomy, epidural anesthesia/analgesia, caesarean section, forceps or vacuum delivery, time of labour, episiotomy, perineum lacerations, general well-being of the newborn evaluated by the APGAR score. The selection of variables was structured based on the main aim of the Polish standard for perinatal care, which is 'obtaining a good state of health for the mother and child, while limiting to the minimum necessary medical interventions, in particular: amniotomy, stimulation of uterine contractions, the use of opioids, episiotomy, caesarean section (...)' [14, p.1].

Description of the state of knowledge. On the basis on the systematic review, the authors collected data concerning the impact of prenatal physical activity on the course of labour and delivery (Tab. 1). One of the analyzed variables was the rate of labour induction, which can be defined as any procedure and treatment that could induce labour. In hospitals, the most commonly used surgical techniques and/or the pharmacological (prostaglandins or oxytocin), when the induction of labour is supported by medical indications [37]. According to the Cochrane Review by Gülmezoglu et al. [38] routine induction of labour in pregnancies carried to the 41st week of gestation is a safe activity. However, as with

Table 1. Influence of prenatal physical activity on selected parameters of labour and delivery.

Author(s)/ date of publication	Sample	Study design/ exercise programme design	Selected variables describing the course of labor and delivery among active women in comparison to inactive/control groups					
			labour induction(I) augmentation (Au)/ amniotomy (Am)	anesthesia/ analgesia	cesarean section (CS) operative vaginal delivery (OVD):	length of labor	episiotomy (E)/ perineal lacerations (L)	Apgar scores
Clapp (1990)	131 TG=87 C=44	Prospective observational comparative study/ Training group continued their prepregnancy running or aerobics programmes, monitored and evaluated throughout pregnancy	I: NS Au: lower Am: lower	lower	CS: lower OVD: lower	shorter	E: lower L: not reported	higher
Kardel and Kase (1998)	42 21 – medium intensity group 21 – high intensity group	Prospective observational comparative study/ Structured conditioning programme of medium or high intensity monitored throughout pregnancy until 6 weeks after delivery	I: not reported Au: not reported Am: not reported	NS	CS: not reported OVD: NS	NS	E: lower L: not reported	NS
Bungum et al. (2000)	137 A=44 S=93	Non-experimental, retrospective study/ Physical activity self-reported in questionnaire. Subjects attended hospital- based childbirth education classes or prenatal aerobic exercise programme in a fitness centre	I: NS Au: not reported Am: not reported	NS	CS: NS; lower after logistic regression analysis with selected variables (OR=4.48; 1.23-16.23) OVD: NS	NS	E: NS L: not reported	not reported

Table 1 (Continuation). Influence of prenatal physical activity on selected parameters of labour and delivery.

Author(s)/ date of publication	Sample	Study design/ exercise programme design	Selected variables describing the course of labor and delivery among active women in comparison to inactive/control groups					
			labour induction(I) augmentation (Au)/ amniotomy (Am)	anaesthesia/ analgesia	cesarean section (CS) operative vaginal delivery (OVD):	length of labor	episiotomy (E)/ perineal lacerations (L)	Apgar scores
Magann et al. (2002)	750 active-duty pregnant women divided into 4 groups based on exercise level	Prospective observational study/ Data collected by questionnaire. Subjects could participate in regularly scheduled physical training of the Navy	I: higher in heavy exercise group Au: higher in heavy exercise group Am: not reported	not reported	CS: NS OVD: NS	longer in heavy exercise group	E: not reported L: NS	not reported
Salvesen and Mørkved (2004)	301 TG=148 C= 153	Randomised controlled trial/ A structured pelvic floor muscle training programme supervised once a week	I: not reported Au: NS Am: not reported	NS	CS: lower acute CS in the first stage OVD: NS	NS less deliveries with prolonged second stage	E: lower L: NS	NS
Nathan et al. (2007)	425	Retrospective case-control study/ No exercise programme; physical activity self-reported in questionnaire postpartum	I: NS Au: not reported Am: not reported	not reported	CS: NS OVD: not reported	not reported	E: not reported L: not reported	not reported
Agur et al. (2008)	268 TG=139 C= 129	Randomised controlled trial/ Structured pelvic floor muscle training programme supervised once a month	I: NS Au: not reported Am: not reported	NS	CS: NS OVD: NS	NS	E: NS L: NS	not reported
Baciuk et al. (2008)	71 TG=34 C=37	Randomised controlled trial/ A structured water aerobics programme, monitored	I: not reported Au: not reported Am: not reported	lower	CS: NS OVD: not reported	NS	E: not reported L: not reported	NS
Bø et al. (2009)	18,865	Cohort Study No exercise programme; data on pelvic floor muscle exercise level collected by self-completed questionnaires	I: not reported Au: not reported Am: not reported	not reported	CS: NS OVD: NS	not reported	E: NS L: NS	not reported
Bovbjerg et al. (2009)	1,955	Retrospective study/ Frequency of exercise during last 3 months of pregnancy self-reported in questionnaire postpartum	I: not reported Au: not reported Am: not reported	not reported	CS: NS OVD: not reported	not reported	E: not reported L: not reported	not reported
Melzer et al. (2010)	44 A=27 S=17	Observational study/ No exercise programme; level of physical activity calculated according to activity-related energy expenditure and movement monitoring	I: not reported Au: not reported Am: not reported	NS	CS: NS OVD: NS lower adjusting for parity, maternal weight gain, and newborn birth weight (OR=7.65; 1.23-16.08)	NS in first stage; shorter second stage	E: NS L: NS	NS
Dias et al. (2011)	42 TG=21 C=21	Randomised controlled trial/ Structured pelvic floor muscle training programme supervised once a week	I: not reported Au: not reported Am: not reported	not reported	CS: NS OVD: NS	NS in first stage and total duration; shorter second stage	E: NS L: NS	NS
Ghodsí et al. (2012)	174 Nos. of subjects in TG and C not reported	Experimental study, not randomized/ Participants performed structured exercise programme at home after a first supervised session. Perinea massage was a section of exercises	I: not reported Au: not reported Am: not reported	not reported	CS: not reported OVD: not reported	shorter first stage; NS in second stage	E: NS L: NS	not reported

TG – training group

C – control group

A – active group

S – sedentary group

NS – differences not statistically significant

any treatment, the induction of labour should be approached with caution as induced labour may be perceived as more painful [39]. According to other sources, induction of labour is associated with a significantly increased risk of caesarean delivery, a higher risk of uterine rupture, more frequent need to use anesthesia, neonatal resuscitation, admission of a child to a neonatal intensive care unit, and the use of phototherapy which, in turn, prolongs hospitalization [40, 41, 42, 43]. Intravenous oxytocin infusion is also used to augment labour if unsatisfactory progress in labour is diagnosed [39, 44], which may also increase pain and the risk of uterine hyperstimulation. Taking all of this into account, any methods should be considered which will reduce the need for labor induction or oxytocin augmentation, also the regular physical activity antepartum.

Beckmann and Beckmann [19] proved that the primiparas participating in a structured, non-endurance strength training programme for a minimum of 12 weeks during pregnancy were less likely to require oxytocin augmentation of labour, and more likely to have spontaneous deliveries in comparison to the control group. Clapp [20] studied the effect of physical activity on the course and outcome of labour among 131 well-conditioned recreational athletes. Comparisons were made between the 87 women who continued to exercise regularly at or above 50% of their pre-conception level throughout pregnancy, and the 44 who discontinued their regular exercise regimen before the end of the first trimester. There were no differences in labour induction between the groups. However, the rate of stimulation for abnormal labour pattern was significantly lower in the exercising group. Nathan et al. [31], having collected data by anonymous questionnaire postpartum, found that increased physical or sexual activity in the third trimester and at the very end of pregnancy were not associated with a decreased labour induction rate. Antenatal pelvic floor muscle training (PFMT) does not appear to influence the rate of labour induction [32] nor oxytocin augmentation [28]. Contrary to the above studies, in the prospective study among active-duty pregnant women, subjects of the heavy exercise group, who did regularly scheduled physical Navy training throughout the pregnancy, were more likely to need an induction or augmentation of labour with oxytocin in comparison to women who stopped exercising before 20 weeks gestation [30].

One of the most commonly performed procedures in modern obstetric and midwifery practice is intentional artificial rupture of the amniotic membranes during labour, called amniotomy or 'breaking of the waters'. The primary aim of amniotomy is to speed-up contractions, and therefore shorten the length of labour. However, there are concerns regarding unintended adverse effects on the mother and infant [45]. In the analyzed studies, little data was found regarding the relationship between prenatal physical activity and the need for amniotomy. Clapp [20] reported that the rate of artificial rupture of membranes was statistically significantly lower in the exercising group than in the control group.

No one questions that labour and birth can be a physically painful experience for many women. Less well known is the fact that some women in all cultures have labours that are essentially painless [3]. There are currently many methods, both natural and pharmacological offered to women in order to alleviate labour pain. [5]. One widely used form is epidural analgesia, which appears to be very effective in reducing pain

during labour. Epidural analgesia is a central nerve block technique achieved by injection of a local anesthetic close to the nerves that transmit pain. However, in the meta-analysis based on Cochrane Pregnancy and Childbirth Group's Trials Register, Anim-Somuah et al. [46] reported that women who use this form of pain relief are at increased risk of having an instrumental delivery. There are some concerns regarding the impact of epidural analgesia on the risk of caesarean section, maternal satisfaction with pain relief, and long-term backache and condition of the baby. However, these were not proved in the Cochrane Review. Women value being encouraged and supported in labour without using pharmacological pain relief by midwives [47].

The question should be asked: how regular physical activity, resulting in a series of changes in the mental and physical health of women, including reducing labour anxiety level [48], can reduce the need for anesthesia? One study reported that women exercising regularly until the end of pregnancy had a statistically significant lower rate of use of epidural anesthetic than those who stopped their physical activity in the first trimester [20]. In the randomized, control trial by Baciuk et al. [24], labour analgesia was requested by significantly fewer women in the group attending a water aerobics programme three times a week in comparison to the controls. There were no significant differences between active and inactive women in use of spinal/epidural in the observational study by Melzer et al. [27]. Other authors found that antenatal pelvic floor muscle training has no effect on the epidural rate [28, 32].

Although most deliveries will result in spontaneous vaginal delivery, under some circumstances, additional assistance is required to deliver the infant. Operative delivery is any procedure undertaken to facilitate the delivery of the infant. These procedures may include instrumental deliveries with the use of vacuum or forceps, and caesarean delivery [49]. These procedures were introduced in obstetric practice to save the life or health of the mother and /or child in incorrectly running births, and they carry the risk of many complications for both mother and child. There has been a growing awareness of infant fatality secondary to intracranial haemorrhage, the short-term and long-term morbidity of pelvic floor injury, as well as neurodevelopmental outcomes for children following operative vaginal delivery [50]. Caesarean section carries significant health risks, including increased incidences of postpartum hysterectomy, adhesions, ileus, and placental implantation problems in future pregnancies, as well as an increased risk of a respiratory distress syndrome in the newborn [51].

According to the WHO guidelines [52], caesarean sections are justified only in 10–15% of births. In contemporary civilization there is the phenomenon of so-called industrialized childbirth and caesarean sections on request, without medical grounds [1]. The Polish Central Statistical Office reports that in Poland in 2010, 33.9% of births ended in this procedure [53]. In some cities in the world, this ratio is even higher, e.g. in Sao Paulo, Brazil, it is 80.4% in the private sector [54]. The reasons for this phenomenon are, on the one hand, abusing the achievements of medicine and too hasty intervention in pregnancy and childbirth by a doctor; on the other hand, lasting lack of interest in the physiology of childbirth [1].

Contemporary women of childbearing age, because of low fitness and physical performance, poor control of their bodies, including the respiratory cycle and muscle tone, are

less and less capable of self-conscious and independent birth. Additionally, the lack of access to reliable information and bad experiences of childbirth passed in social groups result in prenatal anxiety, which strongly reduces the chance of the natural termination of pregnancy [1, 2]. Taking into account the cost of medical treatment, the unjustified use of caesarean sections has global economic consequences [55].

Many studies prove the positive impact of prenatal physical activity on the rate of operative delivery: both caesarean section or instrumental vaginal delivery with the use of forceps or vacuum. Moreover, exercise is known to improve self-efficacy; it may be that women who have increased self-efficacy are more likely to have a 'can do' attitude towards labour, and would therefore be less likely to request an elective caesarean section [33]. Hall and Kaufmann [25] studied 845 pregnant women to evaluate the effects of a structured physical conditioning programme on pregnancy outcomes. They reported that the incidence of caesarean delivery was 6.7% in the high-exercise group, compared with 28.1% in the sedentary group ($p < 0.0001$). Beckmann and Beckmann [19] found that even sporadic participation in a structured training program is associated with a higher rate of vaginal deliveries. In the study by Clapp [20], the women who continued their regular exercise regimen throughout pregnancy had a significantly lower incidence of abdominal (6% vs. 30%) and vaginal (6% vs. 20%) operative delivery than the controls. Bungum et al. [26] concluded in their non-experimental, retrospective study among 137 nulliparous women who regularly participated in physical activity during the first two trimesters of pregnancy, may be associated with reduced risk for caesarean delivery. Through logistic regression analysis with control for the mother's pre-pregnancy exercise programme, age, use of epidural anesthesia, change in pre-pregnancy to delivery body mass index, labour length, whether labour was induced, and the hospital of birth, the odds of caesarean delivery were found to be 4.5 (adjusted OR=4.48; 1.23–16.23) times greater for sedentary women ($n=93$) than for active women ($n=44$). Melzer et al. [27] studied the effects of the recommended levels of >30 minutes of moderate physical activity per day on pregnancy outcomes in 44 healthy Swiss women. The incidence of operative delivery was not significantly different in the active compared to the inactive group (crude OR=3.67; 0.87–16.08). When parity, weight gain, and newborn birth weight were taken into account, the risk of operative delivery was 7.6 times higher in the inactive compared to the active group (adjusted OR=7.65; 1.27–45.84). Maternal self-reported frequency of exercise during pregnancy was not associated with a reduced rate of caesarean delivery among 1,955 women studied by Bovbjerg et al. [33], among 425 women studied by Nathan et al. [31] and among 282 nulliparas in the prospective observational study by Karabulut et al [56]. Baciuk et al. also found no impact of regular physical activity on the type of delivery in the group of previously sedentary women who started water aerobics program at the 18–20 weeks of gestation [24]. Some authors reported that the rate of operative delivery is not influenced by the regular pelvic floor muscle training [28, 32, 34, 36].

Duration of the birth has a significant influence on its correct running. According to NICE [5], birth would be expected to take place within 3 hours of the start of the active second stage in most women among nulliparous women and within 2 hours among parous women. In the case of delay in

the second stage a number of medical procedures are used in order to end labor in the least invasive way possible for the mother and child. Systematic review by Altman & Lydon-Rochelle [57] found evidence of a strong association between prolonged second stage and operative delivery. Statistically significant associations with maternal outcomes such as postpartum hemorrhage, infection, and severe obstetric lacerations were reported. In the study by Cheng et al. [58] the neonates of women with a second stage more than 3 hours had higher risks of 5-minute Apgar score less than 7, meconium stained amniotic fluid, admission to intensive care nursery, composite neonatal morbidity, and longer neonatal stay in the hospital. Given the above and the fact that childbirth is the most painful experience for the mother, efforts by women of his end as quickly as possible seem reasonable. It should also be noted that proper psychophysical preparation and work with an experienced midwife give a chance to natural parturition, although considerably extends its duration [3].

Regarding the effects of physical activity on labor duration, some studies reported that women active during pregnancy experience shorter labor than a control group [19, 20, 21, 23]. Some authors observed that among exercising women either the first stage of labor [22] or the second stage [27, 36] were shorter. Clapp [20] stated that although not specifically examined, the rate of progress in and the duration of labor, coupled with the decreased incidence of protraction disorders in the exercise group, suggested that physical activity in late pregnancy may have had a positive effect on cervical ripening and uterine coordinate activity without initiating preterm labor. Other studies, however, showed no significant difference in labor length between exercisers and controls [24, 28, 29, 32, 35, 36, 59]. Kardel et al. [60] related the conflicting results with the fact that in some studies the parity was not taken into consideration [22, 24, 29, 35, 59]. Duration of labor is longer in nulliparous women [5].

Above reports clearly do not support the concern raised earlier that physical activity, and especially pelvic floor exercises, may increase the resistance of the perineal tissues and prolong labor [61]. There was only one study, examining the labor outcomes among active duty women, where heavy exercising women had longer first-stage labors resulting in longer total labors in comparison to inactive, or light -, or moderate exercising groups [30].

Vaginal delivery causes varying degrees of muscular, neuromuscular, and connective tissue damage. This damage may result in urinary and/or fecal incontinence [51]. Perineal trauma is defined as any damage to the genitalia during childbirth, either spontaneously or due to an episiotomy which is surgical incision of the perineum to enlarge the vulval outlet [62]. According to Northern Trust and Social Care Trust in Northern Ireland, approximately 85% of women will sustain some degree of perineal trauma [62]. Routine episiotomy doesn't prevent urinary incontinence and increases the risk of third- and fourth-degree perineal lacerations, which may lead to fecal incontinence. The advantages of vaginal delivery without episiotomy are numerous, and include less perineal pain and dyspareunia, resulting in an earlier resumption of sexual intercourse [51]. Interventions to reduce the risk of episiotomy and perineal tears are needed.

Clapp observed highly significant reduction in episiotomy in the exercising group [20]. Valgesoo and Linkberg [21] aiming to examine if, and how, pregnancy outcome is affected

by different types of physical activity antepartum found that structured exercise sessions for pregnant women decreases the occurrence of laceration during delivery. Ghodsi et al. [22] showed that prenatal exercises based on current guidelines, performed by samples at their home after a first supervised training session, have no detrimental effect on the occurrence of perineal trauma. The authors had complemented the exercise sessions by a perineal massage. In their study the rates of intact perineum were higher in the trained group in comparison to the controls (36.8% vs. 23.8%) and women in the training group had slightly lower rates of second-degree tears (40.2% vs. 53.6%), although, both of these outcomes did not reach statistical significance. Melzer et al. [27] reported no significant differences between active and inactive women in episiotomy or perineal laceration. Salvesen and Mørkved [28] studied the effectiveness of a structured exercise program for the pelvic floor muscles between the 20th and 36th week of pregnancy among 301 healthy nulliparous women randomly allocated to a training group (n=148) or a control group (n=153). Episiotomy was less frequent in the training group, but there were no statistical differences in the risk of third or fourth degree tears. Structured pelvic floor muscle training affects neither the rate of episiotomy nor perineum lacerations in other studies [32, 34, 36]. Interesting data were obtained by Voldner et al. [63]. Their report indicates that perineal laceration was significantly associated with pregestational physical inactivity (OR: 6.1; 1.6–22.9). According to authors, the mechanisms governing the effect of physical inactivity can only be subject to speculation. Poor physical condition of the mother may reduce the capacity to push resulting in prolonged second stage, which has been associated with higher risk of perineal lacerations [57, 58]. Physical inactivity may also be associated with poorer function of the pelvic levator muscles resulting in insufficient rotational forces and prolonged second stage of delivery.

One of the reasons why in the past pregnant women were advised against physical activity was an unsubstantiated concern that the recurrent, exercise-associated decrease in uterine blood flow and blood sugar levels, coupled with the increase in stress hormones, may deprive the baby of necessary nutrients [64, 65]. This was supposed to have a bad effect on the fetus and its condition after giving birth. This belief is not reflected in the research. A comparison of pregnancy outcome between active and inactive groups of women showed no differences in Apgar scores in the studies by Collings et al. [59], Kardel & Kase [29], Baciuk et al. [24], Melzer et al. [27], Dias et al. [36]. According to Clapp [64], physical activity during pregnancy may be an important mechanism for improving placental capacity, circulation and gas exchange, which in turn increases nutrients delivery and enhance baby's development. In order to achieve the positive effect of placental stimulation it is important to maintain the regularity of suitable exercise intensity throughout the entire pregnancy. Clinical evidence of acute fetal stress (meconium in fluid, abnormal fetal heart pattern resulting in physician action and 1 min Apgar score <7) was less frequent among women who were continuing their aerobic or running training program till the end of pregnancy in comparison with those who stopped in the first trimester (50% vs 26%; p=0.01) [20]. Clapp [64] concluded his observations that it is more difficult to achieve this effect for women who were inactive before pregnancy and begin to systematically exercise only after conception.

The review of the literature shows that regular prenatal physical activity can help to reduce medical interventions during labor, not bearing negative consequences for either the mother or the fetus. In this light it should be seen as one of the important tools for the implementation of the new Polish standard of perinatal care. The authors are aware that this study raises the problem of only some of the variables characterizing parturition. It is interesting to also investigate the relationship between prenatal exercises and the occurrence of diseases specific to pregnancy, premature birth, birth weight and later development. Due to the large scope of the subject, these issues require a separate study.

Reviewed publications report a positive impact or no impact of physical activity on selected parameters of delivery. It has been found only one report by Magann et al. [30], in which the physical exercise resulted in undesirable effects, significantly increasing the risk of induction or augmentation of labor with oxytocin and longer first stages of labor resulting in total longer labors. The key to the analysis of these data is the type of physical effort undertaken by the women studied. The subjects were active-duty women, enlisted in the military. The heavy exercising group participated in regular physical training of the Navy lasting at least 30 minutes for a minimum of three times per week till 28–42 week of gestation. It is worth examining how pro-military exercise carried out throughout the whole or a significant period of pregnancy may alter the hormonal balance of a pregnant woman. It is likely that the direction of her mind to the aggressive, non-maternity tasks, can reduce psychological and physical readiness for the birth, manifested in disorders in its initiation and progression. The onset and course of delivery are significantly influenced by the interaction of hormones, including an appropriate production of oxytocin. Its secretion can be affected by too high catecholamine levels, specific to the state of threat [1]. Russell et al. [66] observed among strenuous exercising athletes that catecholamines elevated by exercise may interact with female hormones. Other study reports that strenuous military training program causes significant changes in the hormone economy in men [67]. Research by Magann et al. may be evidence that not only the quantity but also the quality of prenatal exercise are important in order to get their positive impact on pregnancy and childbirth.

After a review of the literature, we came to the conclusion that in many studies the authors did not devote or not enough attention on characterizing the quality of prenatal physical activity. This is perhaps one of the reasons why the level of physical activity during pregnancy, diagnosed as right, is not always reflected in easier and less medically affected labor. The effectiveness of the training program is determined by the appropriate interaction of the major components: intensity, duration, frequency and type of exercise, suitable for the program's aim [6, 68, 69]. It has been proven that not programmed, spontaneous physical activity undertaken does not bring the desired results for health fitness clubs customers [70]. It can be expected that not programmed prenatal physical activity does not bring a positive impact on the chosen pregnancy outcomes. A pregnant woman should engage in an exercise program that places particular emphasis on precautionary measures that have been incorporated into the exercise regimen to ensure that the program addresses her special needs as an expectant mother. It is not only the safety, strong and healthy body

physical benefits, which is of course one of the priority, but the physical and emotional preparation to the act of giving birth and motherhood [69]. The development of an exercise program requires individual adaptation. Appropriate level of the individual training components should be regularly monitored and evaluated according to the observed progress [64]. The most significant effects are typically observed during the first 6–8 weeks of an exercise program [69]. In working with pregnant women it should be taken into account that the body is additionally burdened by the development of pregnancy, which significantly determines its response to exercise, manifested, among others in faster gains and larger fluctuations in heart rate and increased work of breathing [6, 64, 71]. It significantly alters the management of the intensity of each training session, which sometimes requires extended warm-up and/or cancellation of interval exercises. It should be also considered that due to weight gain, the woman at the same exercise has greater burden and carries out more work in the same unit of time. Therefore, reducing the time for physical activity is not always associated with limiting physical effort. Changing of the body biomechanics as a result of shifting the center of gravity, changes in the curvature of the spine and range of joint motion [72], requires verification of the selected exercises and modification of their techniques. For these reasons, the key is to supervise the implementation of an exercise program for pregnant woman [64]. Most authors in the literature do not provide information about the customization of training programs, the monitoring or evaluation. Some authors recognize that the lack of supervision over the exercise technique performed by pregnant women may result in their lower efficiency [22, 34]. Nielsen *et al.* [73] found that without antenatal instruction on how to perform pelvic floor exercises, women had not regained antenatal pelvic floor contraction pressures by 8 months after vaginal delivery. In contrast, a group of women taught pelvic floor exercises before delivery regained their antenatal pelvic floor muscle strength 8 month postpartum. In the study by Reilly *et al.* [74] patients randomized to supervised pelvic floor exercises attended a physiotherapist at monthly intervals from 20 weeks until delivery. Supervised pelvic floor exercises resulted in a statistically significantly lower incidence of postpartum stress incontinence in the intervention subjects compared with controls. Both the untreated control group and the study group received verbal advice on pelvic floor exercises from their midwives antenatally.

Taking into account the purpose of prenatal physical activity, which is to stimulate the positive development of pregnancy and psychophysical preparation for childbirth and postpartum, each training session should include several elements. In addition to aerobic exercises and exercises strengthening and stretching various muscle groups, typical of basic training [6, 68], a pregnant woman should perform special exercises, including corrective exercises to strengthen and stretch the muscles of the pelvic floor, breathing exercises, relaxation and control of muscle tone, especially in the perineum area. Birth visualization and labour position exercises are also recommended [72, 75, 76, 77, 78, 79]. Such an expertly formulated training programme can be highly effective in activating pregnant woman to participate in the birth, which is one of the fundamental tasks of medical personnel specified in the new Polish standard for perinatal care. According to this document, the doctor

and/or midwife should encourage the pregnant woman to physical activity during the delivery, support her in the choice of breathing techniques and relaxation, help her to choose a comfortable position and method of pushing, as well as in protecting the perineum [14]. Certainly these tasks are easier to accomplish if the pregnant woman was well prepared for them during pregnancy.

Pelvic floor exercises, recommended by the standards for perinatal care in different countries [5, 9, 10, 12, 13, 14], mainly due to their effectiveness in the prevention of urinary incontinence [74, 80, 81, 82] should be one of the components of prenatal physical exercise. They cannot, however, constitute the main content. Some research has shown [32, 34, 36, 73], that training limited to the pelvic floor muscles does not reduce the risk of perinatal interventions. Pregnancy and childbirth is a complex process for the whole of the woman's body, and involves not only the reproductive system. In order to strengthen the adaptive effects of the whole body and prepare a women for childbirth, the physical activity should be aimed at the whole body. It is also important for women to maintain an appropriate level of physical activity throughout the whole reproductive period [83], and begin pregnancy exercises as early as possible [84]. It has been observed that pre-pregnancy physical inactivity was the strongest predictor of decreased maternal exercise in the third trimester [16] and increased the risk of perineal laceration [63]. Women who exercised more earlier in pregnancy reported fewer discomforts later in pregnancy [84]. The lack of positive effects of exercise, or its very limited influence on parturition observed in some studies, may be due to the initiation of physical activity programmes by pregnant women from the second trimester or later [22, 24, 28, 32, 36].

The accurate determination of the impact of prenatal physical exercises on parturition seems to be a very difficult task due to the multitude of variables that may be relevant for the development of psycho-physical condition of pregnancy and women, including their lifestyle, diet, partnerships, professional obligations, economic situation, and many others. In the reviewed publications, data related to these variables was presented infrequently. Many studies were conducted with small groups [21, 23, 24, 26, 29, 32, 36, 59, 85], which makes it difficult to generalize the results on the whole population. The authors of some review studies [86, 87], in an attempt to identify the effect of physical exercises on pregnancy outcomes, noticed the poor quality of some of the research methodology of this subject published a few years ago. Another potential limitation of several papers is that the data are obtained from self-completed questionnaires [15, 33, 34, 35, 88]. This method seems to be the most accurate to identify the motives and barriers to physical exercises and to assess the level of knowledge on physical activity during pregnancy, and also to collect opinions on the quality of perinatal care. It also bears no equipment costs [89] and is easy to organize, thereby allowing research in multi-thousand or larger samples. The Pregnancy Physical Activity Questionnaire [90] and Kaiser Physical Activity Survey [91] have proved to be reliable instruments and a reasonably accurate measure of a broad range of physical activities during pregnancy. However, respondents to questionnaires generally tend to overestimate the level of their physical activity [92, 93, 94]. Hence, results from self-administered questionnaires about exercise level in Poland in 2010 should be interpreted with caution. Many authors question the precision of data obtained

from self-completed questionnaires, emphasizing the need to support the research by relevant devices, such as pedometers and accelerometers [89, 95, 96].

The reviewed publications negate the previous concerns that prenatal physical activity may obstruct labour, delivery, and foetus development. However, concerns about the safety of pregnancy is still one of the main influences for expecting mothers being inactive [15, 16]. A considerable percentage of Polish women (69.42%) reported that pregnancy limited their physical activity [15]. The problem of reducing the level of physical activity with the development of pregnancy is analyzed *inter alia* by Motolla and Cambell [17], and Haakstad et al. [16]. In the absence of either medical or obstetric complications, pregnant women should be encouraged to everyday physical activity and educated that physical exercises of a proper intensity, frequency, duration and mode are not only free of risk, but may have a beneficial effect on multiple aspects of the pregnancy and outcome of labour. Results obtained by Cannella et al. [97] suggest that providing information about the benefits and risks of prenatal physical activity may motivate pregnant women to practice better health behaviours.

Special educational programmes should also be directed to fitness instructors and trainers. A knowledgeable fitness professional, working closely with the women's physician, can make exercise a safe (for both the mother and the foetus), productive and enjoyable endeavour [69]. Prior to participation in an exercise programme, women with or without a previously sedentary lifestyle should be evaluated by their obstetric provider to determine whether exercise is contraindicated. The American College of Sports Medicine advises fitness professionals to administer the Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for Pregnancy) questionnaire to prospective clients to determine the appropriateness of participation in a fitness routine [68]. The PARmed-X [98] includes a tear-away medical clearance form to be signed by the obstetric provider verifying the safety of exercise, along with recommendations for cardiorespiratory and resistance training activities. This questionnaire should be promoted and adapted for use in other countries. Detailed instructions for designing a prenatal exercise programme should be included in the new guidelines for physical activity during pregnancy, both in Poland and abroad. These guidelines should also apply to the needs of women who are very physically active prior to pregnancy [99], including top athletes.

In order to increase the effectiveness of the cooperation of medical and physical education personnel in the implementation of prenatal physical activity programmes, specialized training in this subject directed at the doctors and midwives seems necessary. In order to fulfill the standard for perinatal care for the promotion of healthy lifestyles among pregnant women, physicians should be aware of the multi-faceted benefits of prenatal exercise. It should be noted that while the association of prenatal physical activity with limiting medical interventions during labour is debatable, its impact on reduced risks of pre-eclampsia, gestational diabetes and gestational hypertension [100, 101], excessive gestational weight gain [101], and urinary incontinence in the short term [74,80,81], has been well documented.

It is a significant fact that more than a half of the Polish women examined by Wojtyła et al. [15] admitted that the gynecologist did not mention the problem of physical

activity in pregnancy. What is more, 11% of women were recommended to limit physical activity in pregnancy without reporting any contraindications. In the study by Haakstad et al. [16], only 36% of Norwegian pregnant women surveyed reported that they had received advice from a physician or midwife about physical activity at least once during their pregnancy. Pregnant women visit their health care provider on a regular basis throughout pregnancy, and this may be an open source for providing information on the benefits of regular exercise during pregnancy [16, 102].

CONCLUSIONS

The analysis of the literature leads to the following conclusions:

1. To support or negate the hypothesis of positive effects of physical activity on the course of labour and delivery, well-designed research trials should be conducted with the properly structured prenatal exercise programme in the intervention groups.
2. Detailed instructions for designing a prenatal exercise programme should be included in the new guidelines for physical activity during pregnancy, both in Poland and abroad.
3. The use of a specialized physical exercise programme during pregnancy to prepare women for childbirth is not associated with any risk to the mother or the foetus, and may help to reduce medical interventions during labour, which in turn will improve the condition of the mother and the child, and reduce the cost of perinatal care.
4. In the light of the reduction of physical activity during pregnancy, there is a need to promote regular physical activity of pregnant women as a necessary part of their lifestyle. It is essential that such education covers women, medical personnel, and physical education staff in the planning and implementation of health promotion programmes of physical activity in pregnancy and childbirth.
5. It is necessary to develop tools of cooperation between the pregnant woman, the person managing her pregnancy and the recreation instructor or trainer, according to the Canadian PAR-medX questionnaire for Pregnancy, updated and adapted to the needs of the populations of different countries.
6. The analyzed data indicate that regular physical activity throughout pregnancy may have a beneficial effect on multiple aspects of the course and outcome of labour and delivery. It should be an important tool in the implementation of the Polish standard for perinatal care.

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