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The impact of physical activity during pregnancy on labor and delivery

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Abstract

BACKGROUND: Physical activity in pregnancy is associated with decreased risks of adverse pregnancy outcomes such as gestational diabetes and preeclampsia. However, the relationship between the amount and type of physical activity during pregnancy and subsequent labor outcomes remains unclear.

OBJECTIVE: This study aimed to test the hypothesis that higher levels of physical activity across different lifestyle domains in pregnancy are associated with a shorter duration of labor.

STUDY DESIGN: This study is a secondary analysis of a prospective cohort study in which patients with singleton pregnancies without a major fetal anomaly were administered the Kaiser Physical Activity Survey in each trimester. The Kaiser Physical Activity Survey was designed specifically to quantify various types of physical activities in women and includes 4 summative indices—housework/caregiving, active living habits, sports, and occupation. The study included women at full-term gestations admitted for induction of labor or spontaneous labor. The primary outcome of this analysis was duration of the second stage of labor. Secondary outcomes were duration of the active stage, prolonged first and second stage, mode of delivery, rates of second-stage cesarean delivery, operative vaginal delivery, severe perineal lacerations, and postpartum hemorrhage. These outcomes were compared between patients with and without high physical activity levels, defined as overall Kaiser Physical Activity Survey score ≥75th percentile in the third trimester. Multivariable logistic regression was used to adjust for obesity and epidural use. In addition, a subgroup analysis of nulliparous patients was performed.

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RESULTS: A total of 811 patients with complete Kaiser Physical Activity Survey data in the third trimester were included in this analysis. The median Kaiser Physical Activity Survey score was 9.5 (8.2–10.8). Of the 811 patients, 203 (25%) had higher levels of physical activity in pregnancy. There was no difference in the duration of the second stage of labor between patients with and without higher physical activity levels (1.29±2.94 vs 0.97±2.08 hours; *P*=15). The duration of active labor was significantly shorter in patients with higher levels of physical activity (5.77±4.97 vs 7.43±6.29 hours; *P*=.01). Patients with higher physical activity levels were significantly less likely to have a prolonged first stage (9.8% vs 19.4%; *P*<.01; adjusted relative risk, 0.55; 95% confidence interval, 0.34–0.83). However, rates of prolonged second-stage cesarean delivery, operative vaginal deliveries, and perineal lacerations were similar between the 2 groups.

CONCLUSION: Patients who are more physically active during pregnancy have a shorter duration of active labor.

Keywords

activity; duration; exercise; KPAS; labor

Introduction

Physical activity during pregnancy has been associated with decreased risks of adverse maternal and neonatal outcomes, including, but not limited to, gestational diabetes, preeclampsia, and macrosomia.[1–5] For this reason, regular exercise is strongly encouraged throughout pregnancy. The American College of Obstetrics and Gynecology recommends that women without contraindications should engage in aerobic and strength-conditioning exercises before, during, and after pregnancy.[6] However, the World Health Organization describes physical activity as more than intentional exercise. It defines physical activity as “any bodily movement produced by skeletal muscles that requires energy expenditure… including during leisure time, for transport to get to and from places, or as part of a person’s work.” As many forms of physical activity can contribute to a person’s overall health and well-being, it is important to consider all aspects of physical activity rather than only exercise for a global picture of energy expenditure.[7]

However, the relationship between physical activity before and during pregnancy and labor outcomes is unclear. Previous studies examining the relationship between exercise and labor outcomes show mixed results, with some studies suggesting that increased physical activity may decrease duration of the first and second stages of labor and perineal lacerations, and others with negative results.[8–11] These studies measured physical activity using participation in exercise training programs during pregnancy. Few of these studies looked at the impact of diverse physical activities in pregnancy in addition to exercise, such as activity related to occupations or caregiving. In addition, a limited number of these studies used a quantitative assessment tool to quantify physical activity levels during pregnancy.

The Kaiser Physical Activity Survey (KPAS) was designed specifically to quantify physical activity in women. It contains 4 summative activity indices, including housework/caregiving, active living habits, sports, and occupation. Scores range from 4 to 20, with a maximum

of 5 points assigned for each category. KPAS has been studied extensively in pregnancy and found to be a valid and reliable tool to measure physical activity levels, specifically in pregnant patients.[12,13] It has been used in studies as a means to measure physical activity in multiple facets of life and correlate these scores with common perinatal outcomes, including gestational diabetes, hypertensive disorders of pregnancy, and preterm delivery.[5]

Because labor is a physically arduous process, this study aimed to determine if higher levels of physical activity in pregnancy, as determined by the KPAS score, are protective against adverse labor outcomes. The association between physical activity in pregnancy and duration of the second stage of labor was studied, as this stage is particularly physically demanding. In addition, duration of the first stage of labor as a secondary outcome was assessed as prolonged labor is associated with adverse outcomes.[14]

Materials and Methods

This study is a secondary analysis of a prospective cohort study carried out at a single tertiary care center where patients were administered the KPAS each trimester from January 2017 to 2020. This study was approved by the Washington University School of Medicine Human Research Protection Office. Patients could enroll in the study until 20 weeks' gestation. In the parent study, patients who had a singleton pregnancy, planned to deliver at our center, were 18 years or older, and those who could speak English were included. Exclusion criteria were a major fetal anomaly affecting delivery timing, conception via in vitro fertilization or patients who were incarcerated. In this secondary analysis, patients were also excluded if they had incomplete KPAS data. Gestational age was determined by the last menstrual period or an ultrasound examination.

Baseline maternal demographics and data on the antenatal and intrapartum course were collected from medical records by trained research staff. The primary outcome for this analysis was duration of the second stage of labor. This was selected as the primary outcome given our hypothesis that the second stage of labor requires the most patient-driven physical efforts. Secondary outcomes were duration of the active stage of labor (defined as duration of labor from 6 cm cervical dilation to 10 cm dilation), rates of second-stage cesarean delivery, operative vaginal deliveries, severe perineal lacerations (third or fourth degree), postpartum hemorrhage, prolonged first stage of labor (defined as >75th percentile of the cohort stratified by parity: >20 hours for nulliparous patients and >14 hours for multiparous patients), and prolonged second stage of labor (defined as >3 hours for nulliparous and >2 hours for multiparous patients).[15] These outcomes were compared between patients with lower and higher physical activity levels, defined as third-trimester KPAS score 75th percentile and <75th percentile, respectively. The third-trimester KPAS score was used to most accurately reflect the physical activity levels specifically during pregnancy, as the KPAS questions target exercise levels over the previous 12 months.

A subgroup analysis was performed comparing primary and secondary outcomes in nulliparous patients only to determine if parity played a role in the relationship between physical activity and labor outcomes. Additional secondary analyses were performed comparing primary and secondary outcomes using first- and second-trimester KPAS scores.

Baseline characteristics of patients with lower and higher physical activity levels were compared using univariate analyses. Continuous outcomes were compared using the Student's *t* test or Mann-Whitney *U* test. Categorical outcomes were compared using the χ^2 or Fisher exact test. Primary and secondary outcomes were compared using the Mann-Whitney *U* test. Multivariable logistic regression was used to adjust for obesity and epidural use. Confounders were selected on the basis of biological plausibility and results of the univariate analyses. The initial model included maternal age, race, body mass index (BMI), obesity, gestational age at delivery, gestational hypertension, preeclampsia, tobacco use, illicit drug use, oxytocin use, and epidural use. Backward stepwise elimination was used to reduce the number of variables in the model. The final model included obesity and epidural use because other factors were either colinear with obesity or did not have at least a 10% effect on the model. Because the frequency of some outcomes was >10% and the odds ratio would overestimate the relative risks, aRR was estimated using the method proposed by Zhang et al.[16]

Results

Of the 1200 patients who completed KPAS during pregnancy, 811 patients had complete KPAS data in the third trimester and were included in this analysis. Overall KPAS scores ranged from 4 to 15 with a median score of 9.5. The 75th percentile for KPAS score was 10.8 (Figure 1). Using this cutoff, 25% of the patients (n=203) had higher physical activity levels and 75% of the patients (n=608) had lower physical activity levels (Figure 2). The higher physical activity group had higher scores in all domains within the KPAS. Patients in the higher physical activity group had the highest domain-specific scores in sports, followed by occupation and active living. Patients in the lower physical activity group had the highest domain-specific scores in active living and the lowest scores in sports (Figure 3).

Baseline characteristics were compared between patients with lower and higher levels of physical activity (Table 1). Maternal age was significantly greater in the higher physical activity group than the lower physical activity group (29.93±4.76 vs 28.16±5.41 years; $P<.01$). However, the proportion of patients with advanced maternal age was similar between the 2 groups (10.8% vs 9.2%; $P=.59$). Patients with higher levels of physical activity were more likely to be White (68.5% vs 41.4%; $P<.01$) and less likely to be African American (27.6% vs 53.8%; $P<.01$) than patients with lower physical activity. In addition, patients with higher levels of physical activity had a lower BMI at the start of pregnancy (26.81±6.38 vs 29.64±8.74 kg/m^2;$P<.01$) and were less likely to be obese than patients with lower physical activity levels (23.6% vs 40.0%; $P<.01$). Women with higher levels of physical activity were less likely to receive oxytocin (53.2% vs 66.0%; $P<.01$) or an epidural in labor (75.4% vs 82.4%; $P=.04$). There was a significant difference in birthweight between groups, with the higher physical activity group having higher birthweights than the lower physical activity group (3321 [526] g vs 3197 [589.4] g; $P<.01$), but the rate of macrosomia was similar between both groups. There were no statistically significant differences in parity, pregestational and gestational diabetes, chronic hypertension, and induction of labor between the 2 groups.

The duration of the second stage of labor was similar between patients with higher and lower levels of physical activity (1.29±2.94 vs 0.97±2.08 hours; $P=.15$) (Figure 3). The active stage of labor was significantly shorter in patients with higher physical activity levels (5.77±4.97 vs 7.43±6.29 hours; $P<.01$). Patients with higher physical activity levels were less likely to have a prolonged first stage of labor than those with lower physical activity (9.8% vs 19.4%; $P<.01$; aRR, 0.55; 95% confidence interval,0.34–0.83). Rates of prolonged second stage of labor, second-stage cesarean delivery, operative vaginal delivery, perineal lacerations, and postpartum hemorrhage were similar between the groups (Table 2).

Similar results were seen in a subgroup analysis of only nulliparous patients, where higher physical activity levels were associated with a shorter active stage of labor and lower likelihood of a prolonged first stage. There was no difference in the duration of the second stage of labor or other adverse labor outcomes between the groups (Table 3).

The results were unchanged when using first- and second-trimester KPAS scores. Patients with higher physical activity scores in the first and second trimester had a significantly shorter duration of active labor and a lower likelihood of a prolonged first stage of labor with no difference in the duration of the second stage of labor.

Discussion

This secondary analysis of a prospective cohort study reported that higher physical activity levels during pregnancy are associated with a shorter duration of the active stage of labor and reduced likelihood of prolonged first stage with no difference in the duration of the second stage. This suggests that exercise during pregnancy may play a larger role in uterine contractility than pelvic floor strength, which is responsible for a successful second stage.

Previous studies looking at the effects of physical activity on labor outcomes have shown mixed results. In a randomized controlled trial in which patients were randomly assigned to either an aerobic exercise group or a control group, Barakat et al[17] found that patients in the exercise group had a shorter first stage and total duration of labor. Another trial of nulliparous patients comparing an exercise group with a nonexercising control group found that women who exercised had a shorter duration of the first and second stages of labor, were less likely to require oxytocin augmentation, and were more likely to have spontaneous vaginal deliveries.[18] Conversely, a randomized controlled trial in which patients were randomized to a 12-week exercise program or control group found no difference in the duration of the active stage of labor or the proportion of women with a prolonged second stage.[10] However, none of these studies accounted for active living habits outside of a standardized exercise program that may affect labor outcomes.

Contrary to our initial hypothesis, there was no difference in the second stage of labor between patients with and without high physical activity levels. In the second stage, maximum contraction of the diaphragm increases the intrauterine pressure allowing descent of the fetal head through the pelvic floor muscles, more specifically, the levator ani muscles —puborectalis, pubococcygeus, and iliococcygeus.[19] Previous studies have argued that a lack of elasticity of these muscles and increased muscle stiffening increases the force

required for delivery and may in fact impede the second stage of labor.[20] In fact, more recent studies have used shear wave elastography to measure the elastic properties of the pelvic floor muscles during pregnancy as a risk assessment tool for severe perineal trauma.[21] Using this information, experts propose that athletes are more likely to have rigid pelvic floor muscles that may prolong the second stage of labor and argue that pelvic floor muscle training may in fact decrease the elasticity of these key muscles.[22,23] For this reason, studies have concluded that the role of pelvic floor muscle exercises during pregnancy is not supported by scientific evidence, with a recent study showing no change in adverse labor outcomes with this intervention.[24,25] Therefore, it is plausible that high levels of physical activity during pregnancy may not affect or potentially worsen the elasticity of the pelvic floor muscles that facilitate a shorter second stage of labor.

The association between higher levels of physical activity and a shorter active phase of labor is biologically plausible and may be attributed to increased uterine contractility that has been demonstrated with exercise during pregnancy. Spinnewijin et al[26] measured intrauterine pressure before, during, and after maternal exercise in women admitted for an induction of labor and found that maternal exercise was associated with an increase in uterine activity. Although the physiology behind this finding is understudied, there are several theories. It is possible that noradrenaline, which is released during exercise, acts as a uterine stimulant that increases uterine contractility during pregnancy.[27] Other studies have found that hyperlipidemia may play a role independently of obesity, demonstrating that the addition of cholesterol can inhibit both spontaneous and oxytocin-induced contractions and that its clearance, perhaps with increasing physical activity levels, may improve myometrial contractility.[28,29] Furthermore, exercise is a key component in the formation of cross-bridges between actin and myosin in the skeletal muscles, which leads to the release of calcium ions and results in excitation–contraction coupling.[30] It is believed that this calcium channel activation may also be of relevance in smooth muscle contraction and may play an important role in the physiological process of uterine contractility.[31]

The findings of this study are further supported by previous animal and human studies demonstrating that increased physical activity was associated with higher serum oxytocin levels anda decreased need for oxytocin augmentation in labor.[18,32,33] Ferreira et al[34] demonstrated that pregnant patients who exercise were less likely to require an induction of labor compared with sedentary patients, possibly secondary to a naturally elevated oxytocin level. Although this study showed no difference in the rates of induction of labor between the 2 groups, it showed that patients with high physical activity levels were significantly less likely to receive oxytocin during labor.

Our study has several strengths. First, the large sample size included in this prospective cohort study allowed us to detect differences in the duration of different stages of labor and adjust for an important confounder in this analysis, obesity, as well as epidural use. In addition, this study used a valid and reliable survey whose questions reflect physical activity over the past 12 months as a quantitative measure to assess physical activity levels specifically during pregnancy. This study had broad inclusion criteria and included patients with medical comorbidities, allowing for generalizability. Furthermore, this study is novel

in that it uses a quantitative analysis tool that accounts for activity that is not necessarily intended exercise and measures physical activity in many forms.

There are some limitations of this study that should be considered. First, we were unable to confirm the accuracy of patient-reported data. For example, the addition of pedometer data to validate survey responses would have further strengthened the study. Second, our post hoc analysis demonstrated that our sample size of 811 patients had 80% power to detect a 65% difference in the duration of second stage between patients with and without high physical activity. Therefore, it is possible that smaller differences in the duration of the second stage between groups were not detected. Smaller differences in the duration of the second stage, however, are less likely to be clinically meaningful. In addition, there may be an element of selection bias as there was a subset of patients excluded from the study who did not complete the KPAS in all trimesters. When the patients who never completed any KPAS were compared with the patients who completed in once or more, it was found that African American women were significantly less likely to take the survey (68.4% vs 54.1%; $P<.01$). This highlights an important population of patients with missing physical activity data who should be the focus of future work in this area. This study placed equal weights for each of the KPAS domains; however, the single domains may not carry the same risk of adverse outcomes during labor and delivery. The utility and effect of a weighted score based on domain-specific differences should be considered for future studies. Finally, because there are no published cutoffs for what is considered high or low activity in pregnancy, an arbitrary percentile-based cutoff was selected. Given the rarity of the exposure, this cutoff allowed for adequate power to detect differences in clinically relevant outcomes.

This study concluded that higher physical activity levels during pregnancy are associated with a shorter active stage of labor and decreased likelihood of a prolonged first stage with no difference in the second stage of labor. Future studies should investigate the potential benefits of exercise on uterine contractility and explore what forms of physical activity improve labor outcomes to identify domain-specific interventions during pregnancy.

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AJOG at a Glance

Why was this study conducted?

There is mixed evidence regarding the effects of physical activity during pregnancy on labor outcomes. Previous studies have not included an assessment of various forms of physical activities, in addition to exercise, on labor outcomes.

Key findings

This secondary analysis of a prospective cohort study found that higher levels of global physical activity during pregnancy were associated with a shorter duration of the active stage of labor and decreased likelihood of a prolonged first stage, with no difference in the duration of the second stage.

What does this add to what is known?

The results of this study suggested that physical activity during pregnancy may play a role in improved labor outcomes. This calls for a closer look at the potential physiological benefits of higher global physical activity that is not necessarily centered on exercise alone.

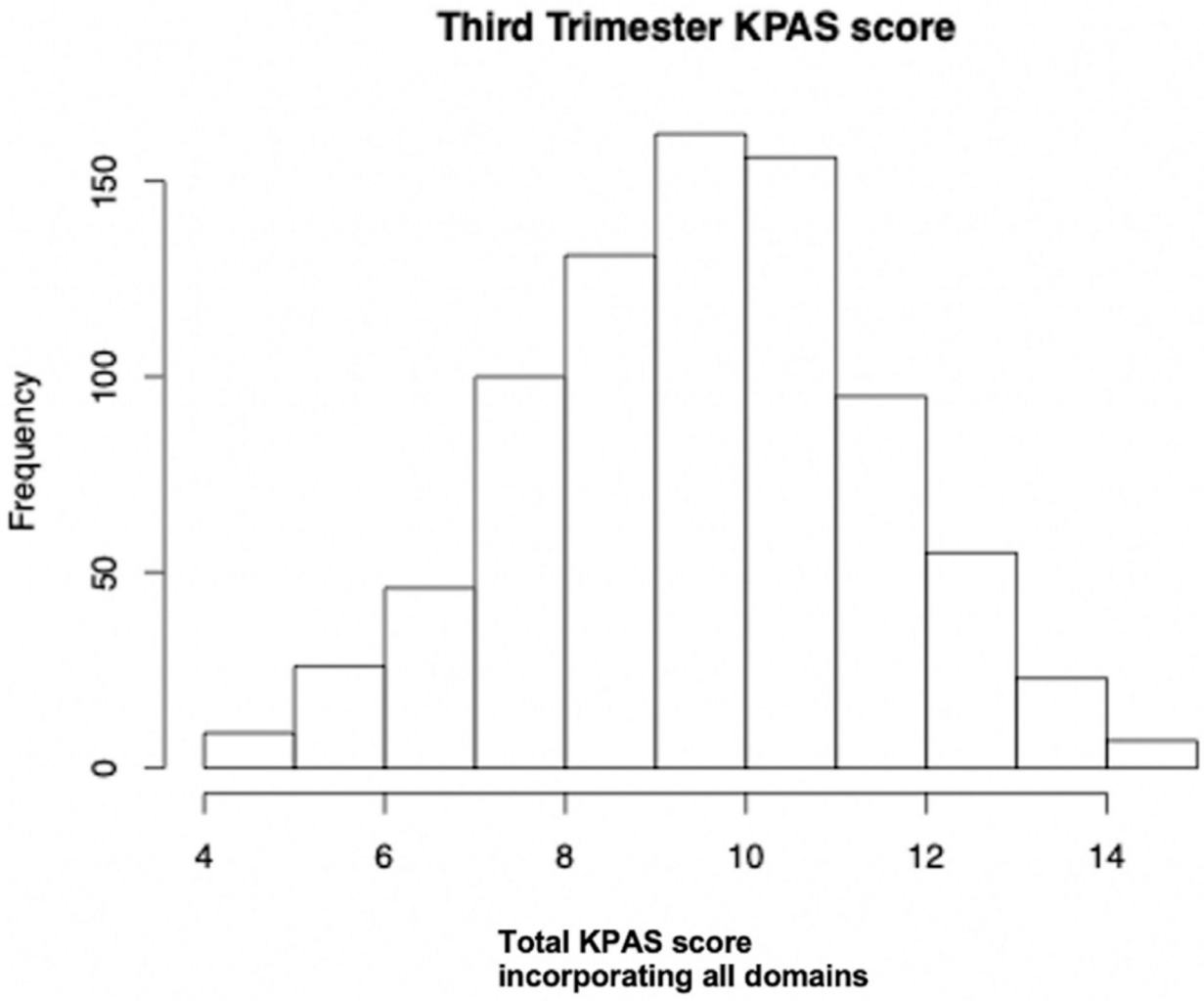

FIGURE 1. Third-trimester KPAS score
KPAS, Kaiser Physical Activity Survey.

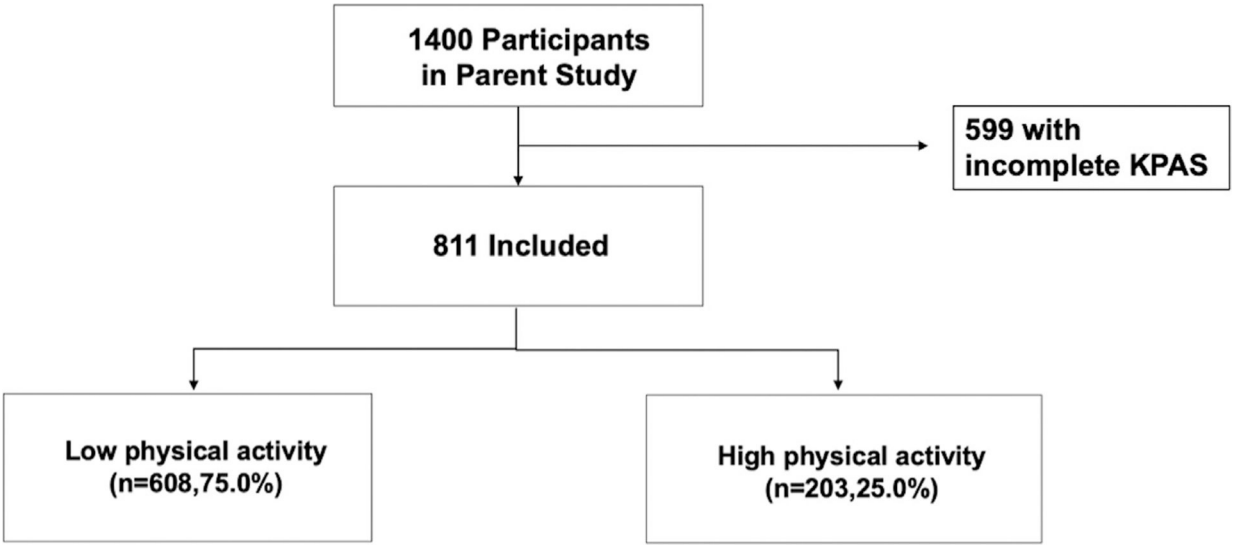

FIGURE 2. Flowchart of study participants
KPAS, Kaiser Physical Activity Survey.

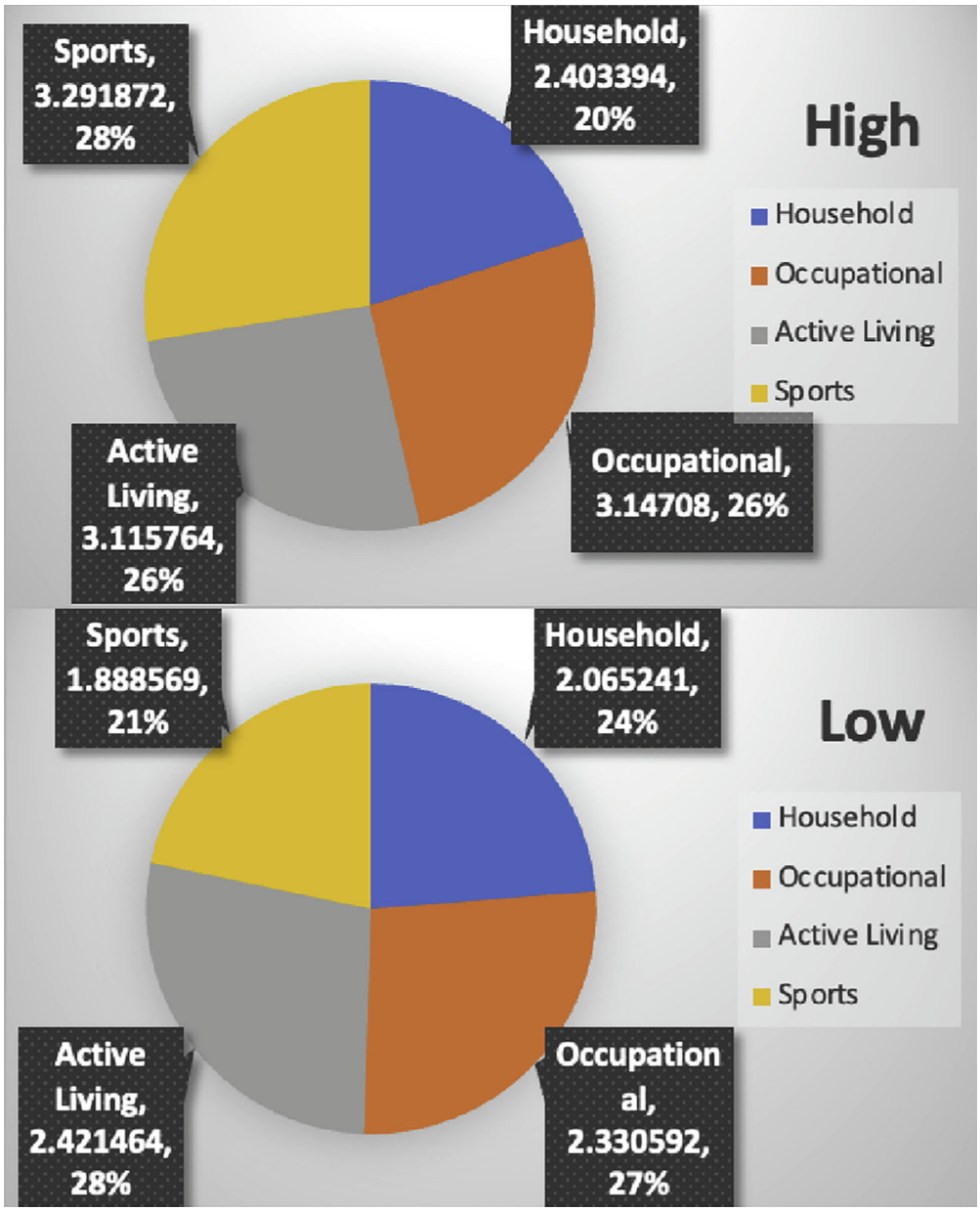

FIGURE 3. Breakdown of KPAS domains by group
KPAS, Kaiser Physical Activity Survey.

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TABLE 1

Maternal demographics in patients with and without high physical activity in pregnancy

Maternal demographics	Lower physical activity (n=608) Reference	Higher physical activity (n=203)	*P*value
Maternal age, y	28.16 (5.41)	29.93 (4.76)	<.01[a]
Advanced maternal age	56 (9.2)	22 (10.8)	.59
Race			<.01[a]
African American	327 (53.8)	56 (27.6)	
White	252 (41.4)	139 (68.5)	
Other	29 (4.8)	8 (3.9)	
BMI (kg/m^2)	29.64 (8.74)	26.81 (6.38)	<.01[a]
Obesity	243 (40.0)	48 (23.6)	<.01[a]
GA weeks at delivery (wk)	38.49 (1.65)	38.82 (1.51)	.01[a]
Preterm birth	61 (10.0)	16 (7.9)	.44
Nulliparity	257 (42.3)	87 (42.9)	.95
Chronic hypertension	64 (10.5)	11 (5.4)	.07
Gestational hypertension	86 (14.1)	16 (7.9)	.05[a]
Preeclampsia	77 (12.7)	10 (4.9)	<.01[a]
Pregestational diabetes	17 (2.8)	3 (1.5)	.49
Gestational diabetes	32 (5.3)	11 (5.4)	.71
Tobacco use	66 (10.9)	8 (3.9)	.01[a]
Illicit drug use	97 (16.0)	14 (6.9)	.01[a]
Alcohol	29 (4.8)	11 (5.4)	.93
Induction of labor	281 (46.2)	81 (39.9)	.14
Oxytocin	401 (66.0)	108 (53.2)	<.01[a]
Duration of active labor, h	7.43 (6.29)	5.77 (4.97)	<.01[a]
Duration of second stage, h	0.97 (2.08)	1.29 (2.94)	.15
Cesarean delivery	180 (29.6)	61 (30.0)	.93
Weight gain, lb	23.1 (31.85)	25.90 (23.83)	.25

Maternal demographics	Lower physical activity (n=608) Reference	Higher physical activity (n=203)	*P* value
Birthweight, g	3,197.1 (589.4)	3,321.7 (526.5)	.01[a]
Birthweight >4000 g, %	37 (6.1)	14 (6.9)	.81
Parity	1.01 (1.24)	1.02 (1.35)	.924
Epidural	501 (82.4)	153 (75.4)	.04[a]

Data represent number (percentage) or mean (standard deviation).

GA, gestational age.

[a] Clinically significant.

TABLE 2

Secondary outcomes in patients with and without high physical activity in pregnancy

Outcome	Lower physical activity (n=608) Reference	Higher physical activity (n=203)	*P*value	RR (95% CI)	aRR (95% CI[a])
Duration of second stage, h	0.97 (2.08)	1.29 (2.94)	.15		
Duration of first stage, h	14.4 (9.46)	10.7 (7.30)	<.01[b]		
Duration of active labor, h	7.43 (6.29)	5.77 (4.97)	<.01[b]		
Prolonged first stage	118 (19.4)	20 (9.8)	<.01[b]	0.51 (0.32–0.79)[b]	0.55 (0.34–0.83)[b]
Prolonged second stage	35 (5.8)	13 (6.4)	.73	1.11 (0.60–2.06)	1.19 (0.62–2.14)
Second-stage cesarean delivery	13 (2.1)	6 (3.0)	.59	1.38 (0.53–3.59)	1.40 (0.49–3.51)[c]
Operative vaginal delivery	27 (4.4)	9 (4.4)	1	1.00 (0.48–2.09)	1.00 (0.45–2.03)
All perineal lacerations	264 (43.4)	100 (49.3)	.17	1.13 (0.96–1.34)	1.11 (0.94–1.29)
Severe perineal laceration	20 (3.3)	5 (2.5)	.65	0.75 (0.28–1.97)	0.68 (0.23–1.68)[c]
PPH	24 (3.9)	7 (3.4)	.84	0.87 (0.38–2.0)	0.86 (0.34–1.88)

Data represent number (percentage) or mean (standard deviation).

aRR, adjusted relative risk; CI, confidence interval; PPH, postpartum hemorrhage; RR, relative risk.

[a]Adjusted for obesity and epidural;

[b]Clinically significant;

[c]Adjusted only for obesity.

TABLE 3

Primary and secondary outcomes in nulliparous patients

Outcome	Lower physical activity (n=257) Reference	Higher physical activity (n=87)	*P*value	RR (95% CI)	aRR (95% CI[a])
Duration of second stage, h	1.32 (1.20)	1.98 (3.10)	.10		
Duration of active labor, h	9.17 (6.66)	6.98 (6.15)	.02[b]		
Prolonged first stage	74 (28.8)	12 (13.8)	.01[b]	0.48 (0.27–0.84)[b]	0.51 (0.27–0.84)[b]
Prolonged second stage	25 (9.7)	10 (11.5)	.68	1.18 (0.59–2.36)	1.27 (0.61–2.44)
Second-stage cesarean delivery	10 (3.9)	6 (6.9)	.25	1.77 (0.66–4.73)	1.85 (0.65–4.84)
Operative vaginal delivery	18 (7.0)	4 (4.6)	.61	0.66 (0.29–1.89)	0.66 (0.19–1.72)
All perineal lacerations	154 (59.9)	54 (62.1)	.80	1.04 (0.85–1.26)	1.04 (0.85–1.23)
Severe perineal laceration	13 (5.1)	3 (3.4)	.77	0.68 (0.20–2.34)	0.62 (0.14–1.86)[c]
PPH	14 (5.4)	3 (3.4)	.58	0.75 (0.19–2.15)	0.62 (0.14–1.77)

Data represent number (percentage) or mean (standard deviation).

aRR, adjusted relative risk; CI, confidence interval; PPH, postpartum hemorrhage; RR, relative risk.

[a]Adjusted for obesity and epidural;

[b]Clinically significant;

[c]Adjusted only for obesity.