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The effect of sedentary behavior during pregnancy on premature rupture of membrane in women above 35 years old

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Abstract

Background: Sedentary life is now considered among the main health risks globally among general population and pregnant women. Premature rupture of membranes is a serious pregnancy condition that is a main cause of newborn morbidity and death globally. There is very limited data about the effect of sedentary behavior during pregnancy on premature rupture of membranes.

Aim and objectives: The current study set out to evaluate the impact of sedentary behavior during pregnancy on premature rupture of the membranes in women older than 35.

Setting and methods: A cohort prospective study was done on 90 pregnant women at Kasr Al-Ainy Hospitals. Participants were met three times (once per trimester). Routine labs and examinations were done and physical activities and sedentary behavior were assessed using prenatal physical activity questionnaire at each visit then pregnant women were followed up till rupture of membranes happened.

Results: A statistically significant difference was observed in the kind and intensity of physical activity among pregnant individuals at the first, second, and third trimesters. Women who experienced premature rupture of membranes demonstrated significantly lower levels of physical activity (household or caregiving, occupational, and low physical activities) and they also showed signs of a more sedentary lifestyle.

Conclusion: Sedentary behavior during pregnancy had great effect on premature rupture of membranes in women above 35 years old. Sedentary participants were twice as likely to develop premature rupture of membranes in contrast to individuals who don't engage in sedentary behavior.

Keywords

Sedentary behavior, physical activity, PROM, pregnancy, women, perinatal outcomes

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Introduction

Physical inactivity and sedentary behavior are now considered among the main health risks globally.[1] Sedentary behaviors are those that consume very little energy at or close to the basal metabolic rate without significantly increasing energy consumption. This corresponds to tasks that need fewer than 1.5 metabolic equivalent units.[2] According to epidemiological research, sedentary activity makes up between 55% and 60% of an adult's waking hours. The condition seems comparable, if not worse, among pregnant women.[3] One of the main risk factors for conditions including metabolic syndrome, cardiovascular disease, and death from all causes is the amount of time spent in sedentary behaviors.[4]

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A fetal membrane rupture that occurs during pregnancy before 37 weeks gestation is referred to as a premature rupture of the membranes. Approximately 5%–10% of deliveries worldwide have premature rupture of membranes (PROM).[5] Premature rupture of membranes is a serious pregnancy problem that is the primary cause of morbidity and mortality among newborns globally.[5] Premature rupture of membranes is the biggest risk to the fetus for preterm delivery problems, respiratory distress, neurodevelopmental abnormalities, and newborn white matter damage, in addition to death.[6] The potential pathways through which sedentary behavior might contribute to PROM are multifaceted and alarming. A sedentary lifestyle can exacerbate oxidative stress (OS), leading to membrane weakening and increasing susceptibility to rupture.[6–8] Moreover, physical inactivity promotes inflammation, which can also compromise membrane integrity.[9] The disruption of blood flow due to a lack of physical activity (PA) might further exacerbate these risks. And while the exact hormonal interplay is still under investigation, it's possible that a sedentary lifestyle disrupts hormonal balance, potentially impacting the delicate processes involved in maintaining membrane strength.[10,11]

Global guidelines have recently recommended that women who are pregnant and do not have any contraindications engage in PA for the duration of their pregnancy and after giving birth. Physical activity is primarily defined as moderate-intensity aerobic and resistance training activities lasting at least 150 min per week, which can also include yoga, stretching, and pelvic floor muscle training. It can lower the risk of weight gain during pregnancy, cesarean delivery, postpartum depression, preeclampsia, and gestational diabetes mellitus.[8–10] The mother, fetus, and infant can all benefit from PA whether utilized as a preventive or therapeutic measure. According to studies, OS can be completely eradicated with consistent low-intensity aerobic activity. Exercise at a moderate intensity helps lower OS in women. Uncertainty surrounds the mechanism underlying PROM, a significant contributor to newborn morbidity and mortality. Pregnancy-related moderate-to-low intensity PA has been shown to lower the risk of PROM.[11,12] PA and PROM during pregnancy may have an association with inflammatory responses and OS. Study on PA and PROM, however, is limited. These few research studied only the effect of sedentary behavior and PA in the first trimester and did not study effect of sedentary behavior and PA in the second and third trimesters. Also, previous studies did not focus on women above 35 years old which is factor in high-risk pregnancy. Also, there are no studies about the effect of SB and PA on PROM in the Arab world.

Thus, the purpose of this study was to assess the effects of PA and sedentary behavior on PROM in pregnant women over 35 during each trimester of pregnancy.

We are hypothesizing that sedentary behavior during pregnancy has great impact on PROM in pregnant women above 35 years old. And the research question was "Does the sedentary behavior during pregnancy affect PROM in pregnant women above 35 years old?"

Methods

One hundred expectant women who visited Cairo University Hospitals' family medicine and obstetric outpatient clinics between January 2022 and March 2023 participated in a prospective cohort study. Only 90 participants completed the study and there were 10 dropouts of participants. Based on assumptions from previous research by Murat et al., 2021 with comparison of incidence of preeclampsia in low PA pregnant women with incidence in moderate and high PA performance as primary outcome. Using Open Epi, Version 3, with the following settings: percentage of exposed with outcome 24 relative risk 26, two-sided significance threshold (alpha): 0.05, power 80%, sample size ratio, unexposed/exposed 1 and percent of unexposed with outcome 1.2, risk/prevalence ratio: 20, and risk/prevalence difference: 23.[13] So calculated sample size will be 82 pregnant women to be included in this cohort study and after considering 8 dropouts so final sample will be 90 pregnant women. Pregnant females above 35 years old with a singleton pregnancy who consented to take part in the research were included. Participant must give informed written consent. Pregnant women known to have any systemic diseases, previous gestational diabetes, pregnancy-induced hypertension, or preeclampsia were excluded. Pregnant women with threatened abortion or a history of habitual abortion were also excluded.

Inclusion criteria

1. Pregnant female with singleton pregnancy.
2. Age: Above 35 years old.
3. Participants must give informed written consent.

Exclusion criteria

1. Pregnant women known to have diabetes mellitus, chronic hypertension, cardiac disease, kidney disease, or any other systemic diseases.
2. Pregnant women known to have previous gestational diabetes, pregnancy-induced hypertension, or preeclampsia.
3. Pregnant women with history of habitual abortion.
4. Pregnant women with threatened abortion.
5. Grand multiparous pregnant women (para 5 or more).
6. Pregnant women with Women who have experienced PROM or had history of premature birth in a prior pregnancy.
7. Women with cervical insufficiency or abnormal AFI.
8. Smoker women.

Data collection for study was done using Prenatal Physical Activity Questionnaire (PPAQ) at first, second, and third trimesters then pregnant women were followed up till delivery to know the gestational age at delivery.

Using accelerometer measurements, Chasan et al.[14] developed and validated the PPAQ. Following that, Papazian et al.[15] verified it by translating it into Arabic. The 31 activities in the PPAQ were broken down into four categories: sports and exercise (9 activities), home and caregiving (14 activities), work (5 activities) and transportation (3 activities). Four categories can be used to group these activities: sedentary (<1.5 MET), vigorous (>6.0 MET), moderate (3.1–6.0 MET), and mild (1.5–2.9 MET).[16] The total PA is determined without factoring in the energy used in sedentary activities. Each activity's average weekly energy expenditure (MET-h•week-1) is determined by multiplying the amount of time spent on it by its intensity. The PA program was used to determine the activities' intensity.[17] After obtaining consent from participants, a detailed history was taken. Routine labs and examinations in each trimester were done. During face-to-face interviews at each trimester, PA characteristics were measured using the PPAQ. Women were followed up during the whole pregnancy until delivery to know when rupture of membranes had happened. Based on the medical history and physical examination of the expectant mother, PROM was diagnosed. PROM was typically diagnosed by observing the passage of amniotic fluid into the vagina from the cervical canal before 37 weeks of pregnancy.

Ethical considerations: The research was revised and approved by the Family Medicine Department and the Faculty of Medicine's Research and Ethical Committees, Cairo University on18/1/2022. The study was conducted after the participants understood the importance and aims of the study. Only those who accepted were included, after receiving their consent.

Statistical analysis

Database software known as the Statistical Package for Social Science (SPSS) version 21 was used to code, enter, show, and analyze the acquired data. The qualitative data was represented using percentages and frequencies. The quantitative variables were represented by the mean and standard deviation (SD). The Chi-square test was employed for inter-variable comparisons. When one or more anticipated cells are less than five, the Fisher exact test was utilized. An independent *t*-test was used to compare a quantitative variable with a normal distribution. For comparing quantitative variables that are not regularly distributed, we use the Mann–Whitney *U* test. *p*-values were deemed statistically significant if they were less than 0.05.

Results

Ninety pregnant women above 35 years old with a mean age of 38.34 ± 2.16 years old were recruited during antenatal visits in first trimester for routine obstetrical checkups. They were assessed again at second and third trimesters and followed up till delivery to assess the effect of sedentary behavior on PROM. Premature rupture of membranes was typically diagnosed by observing the passage of amniotic fluid spontaneously into the vagina from the cervical canal before 37 weeks of pregnancy. PROM had happened in nine of the participants. The study population consisted of pregnant women in Egypt with a mean age of 38.34 years old, with a SD of 2.16 years. While all participants were initially married, 20% were divorced at the time of the study. Additionally, 60% were employed and 75% graduated from different universities. Furthermore, 50% of the women resided in rural areas of Egypt. Interestingly, the total PA scores of participants with PROM and those without PROM did not differ statistically significantly. However, there was a statistically significant difference in the amount of PA among pregnant participants who experienced PROM during the first trimester. Women who experienced PROM demonstrated significantly lower levels of PA (light-to-moderate levels), and they also appeared to lead more sedentary lifestyles (Table 1).

The type of PA that pregnant participants engaged in during the first trimester differed statistically significantly between those who had PROM and those who did not; women who had PROM demonstrated significantly fewer activities related to household or caregiving duties as well as employment (Table 1).

When comparing the type and intensity of PA among pregnant participants in the second trimester, there was a statistically significant difference. Women who experienced PROM demonstrated significantly lower levels of household or caregiving and occupational activities, while they also displayed a more sedentary lifestyle (Table 2).

When comparing the type and intensity of PA among pregnant participants who had PROM during the third trimester, there was also a statistically significant difference. Women who ruptured their membranes prematurely demonstrated significantly lower levels of PA (household or caregiving, occupational, sports, and light physical activities), while they also displayed a more sedentary lifestyle (Table 3).

A statistically significant distinction existed between cases with and without a sedentary lifestyle regarding PROM. All women who developed PROM had a sedentary lifestyle. Participants who engaged in sedentary behavior were twice as likely to acquire PROM relative to people who don't engage in sedentary behavior (Figure 1).

Table 1. Relation of PROM and scores of activities during first gestational trimester among participants.

Variables	With PROM ($n=9$)	Without PROM ($n=81$)	Test (Z)	p-Value
Total score of PPAQ (MET.h/wk) median (IQR)	259.8 (224.6–283.1)	412.9 (227.8–1025.4)	−1.957	0.050
By intensity				
Sedentary median (IQR)	163.8 (85.1–184.4)	40.1 (24.2–150.3)	−2.845	0.004
Low physical median (IQR)	66.9 (52.1–81.8)	154.4 (81.7–347.9)	−2.872	0.004
Moderate median (IQR)	45.5 (25.2–51.5)	115.4 (31.1–644.4)	−2.052	0.040
Vigorous median (IQR)	0	0	−1.456	0.145
By type				
Household/ caregiving median (IQR)	86.7 (70.6–104.7)	150 (95.5–473.9)	−2.684	0.007
Occupation median (IQR)	0 (0–69.8)	91.7 (0–215.5)	−2.276	0.023
Sport/exercise median (IQR)	0.8 (0.8–2.2)	9.6 (0–39.3)	−1.694	0.090

Mann–Whitney test, MET: metabolic equivalent turnover; PROM: premature rupture of membranes.

Table 2. Relation of PROM and scores of activities during second gestational trimester among participants.

Variables	With PROM ($n=9$)	Without PROM ($n=81$)	Test (Z)	p-Value
Total score of PPAQ (MET.h/wk) median (IQR)	300.3 (232.2–381.9)	373.1 (204.6–1048.3)	−1.043	0.297
By intensity				
Sedentary median (IQR)	157.5 (142.8–203.7)	50.8 (21.2–108.9)	−3.558	<0.001
Low physical median (IQR)	74.2 (36.8–104.5)	155.2 (77.5–325.2)	−2.858	0.004
Moderate median (IQR)	53.1 (27.4–77.8)	104.5 (22.5–706.2)	−1.420	0.156
Vigorous median (IQR)	0	0	−0.840	0.401
By type				
Household/caregiving median (IQR)	75.1 (62.8–136.5)	140.2 (81.6–495.3)	−2.253	0.024
Occupation median (IQR)	0 (0–80.1)	100.6 (0–263.5)	−2.136	0.033
Sport/exercise median (IQR)	2 (0–2)	6 (0–30)	−1.837	0.066

Table 3. Relation of PROM and scores of activities during third gestational trimester among participants.

Variables	With PROM ($n=9$)	Without PROM ($n=81$)	Test (Z)	p-Value
Total score of PPAQ (MET.h/wk) median (IQR)	177.6 (167.3–282.7)	318.8 (199.3–1070)	−1.930	0.054
By intensity				
Sedentary median (IQR)	157.5 (157.5–204.1)	78.4 (45.5–117.4)	−3.168	0.002
Low physical median (IQR)	20.7 (10.5–55.5)	131.3 (80–345.8)	−4.150	<0.001
Moderate median (IQR)	7 (3.4–40.6)	65.1 (5.3–675.7)	−1.919	0.055
Vigorous median (IQR)	0	0	−0.474	0.635
By type				
Household/caregiving median (IQR)	25.9 (8.3–72)	133.9 (57.8–486.5)	−3.639	<0.001
Occupation median (IQR)	0 (0–71.8)	107.5 (0–342.7)	−2.079	0.038
Sport/exercise median (IQR)	2 (0–3.6)	5.3 (0–21.8)	−2.050	0.040

Logistic regression analysis was performed to assess possible predictors of PROM such as age, baseline body weight, weight change during pregnancy, occupation, residence, and education. It showed that the development of higher sedentary life was associated with significantly higher odds of PROM. Contrarily, increasing low PA was associated with lower odds of PROM. On multivariable regression to control for confounders, the highest R-square was achieved with the model that included low PA and it was independently associated with PROM (Table 4).

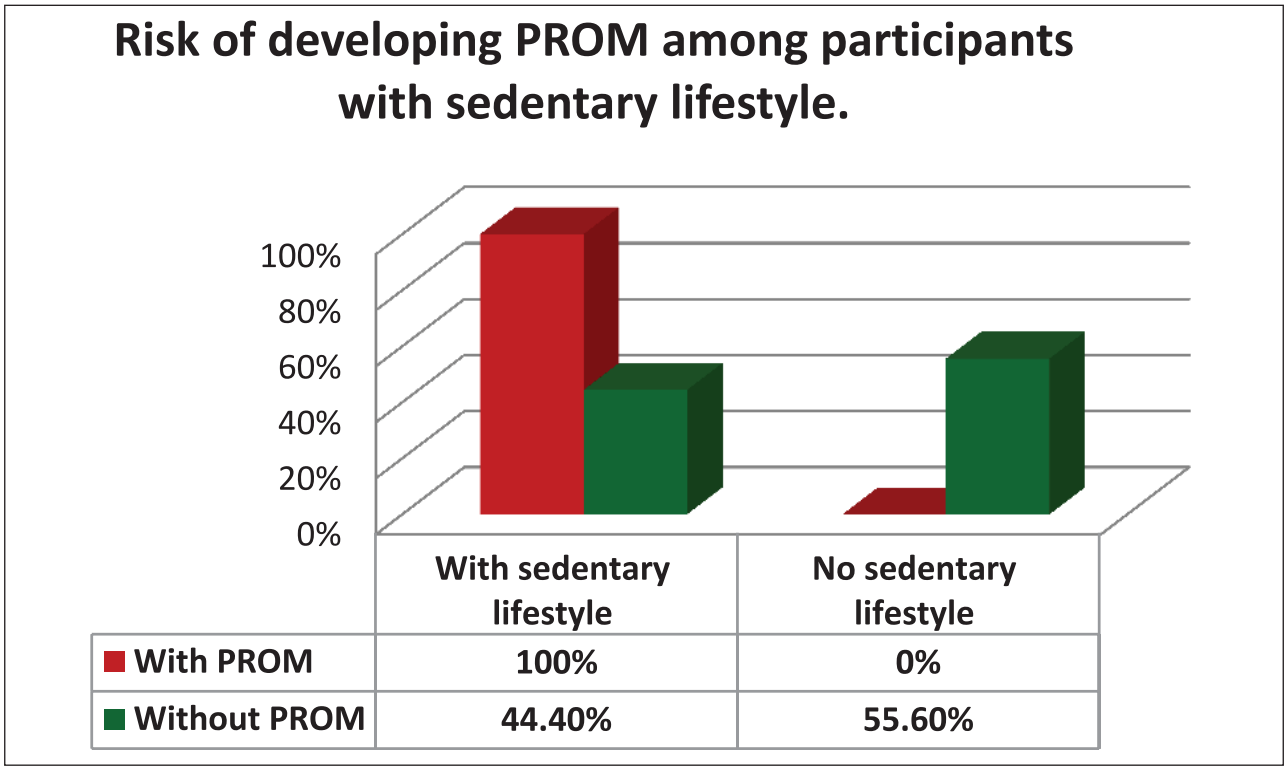

Figure 1. Risk of developing PROM among 90 women above 35 years old who visited Cairo University Hospitals' family medicine and obstetric outpatient clinics between January 2022 and March 2023. Data were collected through PPAQ questionnaire three times (once in each trimester). The Chi-square test was used to determine the association between sedentary lifestyle and PROM. There was statistically significant difference between cases with and without sedentary lifestyle regarding PROM (p-value = 0.002). All participants who developed PROM had sedentary lifestyle. The figure shows that 100% of participants with a sedentary lifestyle developed PROM, compared to 44.4% of participants without a sedentary lifestyle.

Table 4. Logistic regression to control for possible confounders for PROM.

Possible cofounders	Univariable regression		Multivariable regression	
	OR (95% CI)	p	OR (95% CI)	p
Age	1.29 (0.96–1.72)	0.09		
Baseline body weight	1.05 (0.99–1.10)	0.08		
Weight change during pregnancy	1.10 (0.96–1.27)	0.2		
Occupation working versus not	2.02 (0.50–8.09)	0.3		
Residence	0.44 (0.10–1.89)	0.3		
Education	1	—		
Average of sedentary activities during whole pregnancy	1.02 (1.01–1.03)	0.004		
Average of low physical activities during whole pregnancy	0.97 (0.94–0.99)	0.03	0.97 (0.94–0.99)	0.02
Average of moderate activities during whole pregnancy	0.99 (0.98–1.01)	0.3		
Average of vigorous activities during whole pregnancy	1 (0.07–0.28)	<0.0001		
Total score	0.99 (0.99–1.0004)	0.08		

OR: odds ratio; CI: confidence interval.

Discussion

It has been determined that physical inactivity and sedentary behavior are modifiable risk factors for adverse health outcomes in expectant mothers, including PROM. The consequences of PROM are mostly influenced by the gestational age at birth, and it is linked to a prenatal morbidity and mortality rate of more than 20%.[17]

In our study, we found that the incidence of developing PROM was 10% among participants. Choudhary et al.[18]

showed that the incidence of developing PROM was 9.8% among participants at Mahatma Gandhi Medical College and Hospital in India which is near the result of our study. This similarity in incidence rates across different geographic locations and populations suggests that PROM may be influenced by more universal factors than previously thought. This could point to common biological or environmental factors that contribute to PROM, making it a more global health concern. This finding underscores the importance of collaborative global research efforts to better understand PROM. Sharing data and best practices across international borders could lead to more effective prevention and treatment strategies for this significant health concern.

Our study revealed that sedentary behavior had an impact on PROM. Women who developed PROM had a more sedentary lifestyle than women who did not develop PROM. We found that individuals who exhibited sedentary behavior had a twofold higher chance of having PROM compared to others who don't. This is concordant with a study conducted by Yong-Le et al.[19] on 6848 participants in China and found that sedentary behavior during the first trimester is a risk factor for PROM. Thus, SB throughout pregnancy even in the first trimester has a harmful effect on the course of the pregnancy. These findings may shift the focus from "lack of exercise" to "excessive sitting" as the key issue. This allows for a more nuanced approach to interventions and public health messaging instead of simply promoting exercise, emphasize reducing prolonged sitting throughout the day.

Our research also found that women who experienced premature rupture of membrane demonstrated significantly fewer (light to moderate) PA than women who did not have such a condition. This is in line with a study which was conducted in China by Lv et al.[20] on 6284 pregnant women from the Tongji-Shuangliu birth cohort using PPAQ. This study demonstrated that lower chances of (PROM) were linked to women who met recommended levels of light-to-moderate movement and exercise during their pregnancies. Our study also showed that the amount of vigorous activity did not significantly differ between women who developed PROM and women who did not. This reveals a complex relationship between PA and PROM, suggesting that a balanced approach is essential. While vigorous activity doesn't seems to play a significant role, reducing sedentary behavior and engaging in regular light-to-moderate activity during pregnancy appears to be protective. This emphasizes the importance of promoting active lifestyles for pregnant women from the start of their pregnancies, tailoring recommendations to individual needs and limitations. Further research is needed to explore the specific mechanisms by which light-to-moderate activity reduces PROM risk and to develop more effective interventions for pregnant. Our research revealed a significant association between increased sedentary behavior and a higher risk of PROM, while increased low-intensity PA was linked to a reduced risk. To address potential confounding factors, we conducted a multivariable logistic regression analysis, controlling for factors such as age, baseline body weight, weight change during pregnancy, occupation, residence, and education. This analysis demonstrated that the association between sedentary behavior and PROM persisted even after adjusting for these potential confounders. Furthermore, the model with low PA achieved the highest *R*-squared value, indicating a strong fit for the data, and low PA remained significantly associated with a lower risk of PROM. This finding is particularly important because it demonstrates that the observed association between sedentary behavior and PROM is not simply due to its correlation with other potential risk factors such as age, weight change during pregnancy, occupation, residence, and education. Our results also highlight a potentially protective effect of engaging in low PA, which was significantly associated with a lower risk of PROM in both models.

Our study indicated that women who ruptured their membranes prematurely demonstrated significantly fewer activities related to household or caregiving than women who did not. This confirms the findings of the study that was done by Lv et al.[20] and revealed that women who did more housework and childcare during the first trimester and who followed recommended exercise regimens during pregnancy have a lower incidence of PROM than women who did less of either of these tasks. Our research also revealed that no appreciable distinction between the sports activities of women with PROM and those without. The association between reduced household activity and PROM, especially among women above 35 years old, highlights a potential window for early intervention. This finding, coupled with the lack of a difference in sports activities, suggests a potential dose-response effect, where higher levels of overall PA, encompassing both household tasks and structured exercise, may be associated with lower PROM risk. Interventions targeting household activity levels, potentially combined with counseling on recommended exercise, could be explored as a preventative strategy during pregnancy, particularly for older women. Future research with larger sample sizes, longitudinal data, and a focus on diverse populations is needed to confirm these findings and explore the underlying mechanisms.

Limitations

It's important to acknowledge the limitations of our study, including the relatively small sample size and the possibility of unmeasured confounders. Future research with larger sample sizes and a wider range of potential factors is crucial to further clarify the complex relationship between sedentary behavior, PA, and PROM.

Possible bias and how to prevent and control bias

- Selection bias:
  - The participants in this study were recruited from Kasr Al-Ainy Hospital's outpatient clinics. This could potentially introduce selection bias if the participants who chose to attend these clinics were systematically different from the broader population of pregnant women.
- To mitigate selection bias:
  - Kasr Al-Ainy Hospitals are the main hospitals in Egypt and receive patients from everywhere in Egypt.
- Recruitment process bias:
  - The recruitment process may have introduced bias if the participants who agreed to participate were systematically different from those who declined.
- To mitigate recruitment process bias:
  - The recruitment process was carefully designed to be inclusive and not favor any specific demographic group.
  - We provided clear information about the study's purpose, procedures, and potential risks to ensure that participants made an informed decision.
- Data collection bias:
  - The use of the PPAQ questionnaire for data collection could potentially introduce recall bias if participants had difficulty remembering their PA levels over the study period.
- To mitigate data collection bias:
  - We used a validated questionnaire that has been shown to be reliable for assessing PA in pregnancy.
  - The questionnaire was administered by trained research assistants to minimize any misunderstandings or errors in data collection.

Conclusion

We concluded that decreasing sedentary behavior during the whole pregnancy is important to decrease incidence of PROM. Mild, moderate, and household activities are protective factors to reduce incidence of PROM in women above 35 years old.

Recommendations

More studies on effect of sedentary behavior on PROM are needed.

It is important to encourage inactive women to start PA regimens that are suitable for their level of fitness and unique clinical circumstances.

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Author's contribution

Rehab Hanafy Mahmoud Abdelsamiea: Conceptualization, methodology, data analysis, writing – original draft. Ghada Mahmoud Khafagy: Data collection, formal analysis, visualization. Hassan Omar Ghareib; Supervision, visualization. Mai Diaa Sarhan: Supervision, writing – review and editing. Everyone who wrote for the study contributed equally.

Declaration of conflicting interests

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Ethics approval

Ethical approval for this study was obtained from "Research Ethical Committee of the Faculty of Medicine Cairo University (Code: MD-357) on 18/1/2022."

Informed consent

Written informed consent was obtained from all subjects before the study.

Trial registration

Not applicable.

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Supplemental material

Supplemental material for this article is available online.

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