REVIEW ARTICLE

# Predictors of Physical Inactivity Among Antenatal Women: A Systematic Review

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**ABSTRACT**

The American College of Obstetricians and Gynaecologists (ACOG), US Department of Health and Human Services (HHS), and American College of Sports Medicine (ACSM) recommend that all pregnancies with medical clearance should engage in moderate-intensity physical activity (PA) at least 150 minutes per week. However, most of them are physically inactive. Thus, this article aims to identify predictors of physical inactivity among antenatal women. Four databases were used to search relevant articles using PICO strategy systematically. The screening began with examining titles, abstracts, and keywords, followed by scrutinizing and assessing full articles. Finally, a total of five studies were included for the data extraction, and the predictors are sociodemographic (trimesters, parity, marital status, and pre-pregnancy PA status), socioeconomic (household income), lifestyle (smoking and eating unhealthy diet) and health-related factors (multiple pregnancies, received fertility treatment, being unwell, musculoskeletal pain, symptom of early pregnancy and uterine contraction). All these predictors provide crucial information for the success of future physical activity intervention.

**Keywords:** Pregnant women, Physical activity, Physically inactive, Pregnancy, Predictors

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## INTRODUCTION

Physical activity (PA) has a major impact on health. The World Health Organization (WHO) (1) defines physical activity as 'any bodily movement of a skeletal muscle that requires energy expenditures' (p.1). Globally, around 31% of adults aged 15 and over were physically inactive in 2008 with a majority of them being women. Approximately 3.2 million deaths every year are precipitated via inadequate physical activities. (1,2).

Multiple health institutions, like the American College of Obstetricians and Gynecologists (ACOG), the United State Department of Health and Human Services (HHS) and the American College of Sport Medicine (ACSM), recommend that all pregnant and postpartum women should involve in physical activity of moderate intensity at least 150 minutes per week. However, pregnant women, whom have previously practised a sedentary lifestyle, and are currently experiencing medical and obstetrics complications should seek medical evaluation and clearance from doctors before becoming active (3–6). Despite this advice, only 13.8% of pregnant women in the US were physically active (3,4). In Europe and China, the statistics of physically active expectant mothers were 21.5% and 11.1% respectively (7,8). However, there is no data or statistics related to physical activity among pregnant women in Malaysia (9).

Pregnancy is an appropriate time for women to practice a healthier way of living and it should not be used as an excuse to be inactive. Being physically active not only benefits the expectant mother but the foetus(es) as well. Regular exercising improves or keeps physical fitness by assisting with weight management, reducing risk of gestational diabetes in overweight women, lowering the risk of pre-eclampsia and enhancing psychological well-being (10–13). Therefore, the inclusion of physical activities in one's lifestyle is a great way to reduce health risks and ensure a healthy pregnancy.

However, many pregnant women remain physically inactive despite knowing about their pregnancy (14). Previous research revealed that lack of exercise or movement during pregnancy could lead to harmful effects like bleeding, preterm labour and discomfort (15–18). Thus, continuous research is needed to provide up-to-date information on the evolving relationship between physical activity and the health of antenatal women.

The aim of this systematic review is to identify predictors of physical inactivity among antenatal women in order to provide basic information on possible engaging physical activity barrier on specific trimester that helps

healthcare workers to be more focused on promoting PA. Moreover, the levels of PA among pregnant women differ according to their trimesters. They usually become less active as their pregnancy progress due to physiological changes (19,20).

## METHODOLOGY

### Search Protocol

A systematic search was performed on PubMed, CINAHL, SPORTDiscuss and Google Scholar databases covering from 2009 to June 2018. Searches were done in mid-2018 (April to June 2018). Search strategy follows the PICO strategy and the search was done by dissecting titles, abstracts and keywords. The terms used for P (Population or Problem) were antenatal OR pregnant women OR pregnant woman OR pregnant* OR gestation* OR gravid* OR pregnancy trimester* OR expectant mother AND physical inactive OR insufficient physical activity OR low energy expenditure. The terms used for I (Intervention) were exercise OR physically active. There was no term search for C (Comparison). Lastly, the terms used for O (Outcome) were risk ratio OR relative risk OR predictors OR determinants OR barriers. Final result consists of all PICO terms searches; i.e. P AND I AND O. There was no restriction placed on location and only English language article was chosen. Unpublished literatures were not searched in this systematic review.

### Study Selection

It started with selection of studies based on title. Then, studies that have been chosen for the first screening process were each randomly allocated to two reviewers who were best suited for a study based on the abstract and keywords of the articles. Both reviewers must reach an agreement in order for the study to be accepted into the next phase of screening. If both of these reviewers fail to agree, a third reviewer will be involved in the screening process and decision for accepting the study will be made by a consensus from all three reviewers. However, no study required a third reviewer. Then, selected articles from the first screening process were retrieved for further inspection and examination for the full article. It involved two other reviewers, different from the previous ones. Each of them were required to review each study to extract data for the full article. Studies were included if (1) the study was an original article (not a review or commentary); (2) the articles include participants among antenatal women with specific gestation (≤ 12 weeks, 13-28 weeks, ≥ 29 weeks); (3) it is an observational study (cross-sectional, case control or cohort study) that measured risk ratio, relative risk or beta coefficient (multiple logistic or multiple linear regression) ; (4) it is a cohort study with at least two follow-up; (5) it is a case-control study that selected sampling from a same based population; and (6) it uses tools that are calibrated and validated. Whereas, the exclusion criteria were (1) the absence of full article in English language; (2) populations other than pregnant women; and (3) articles with no study design. The selection flow was summarized in Figure 1.

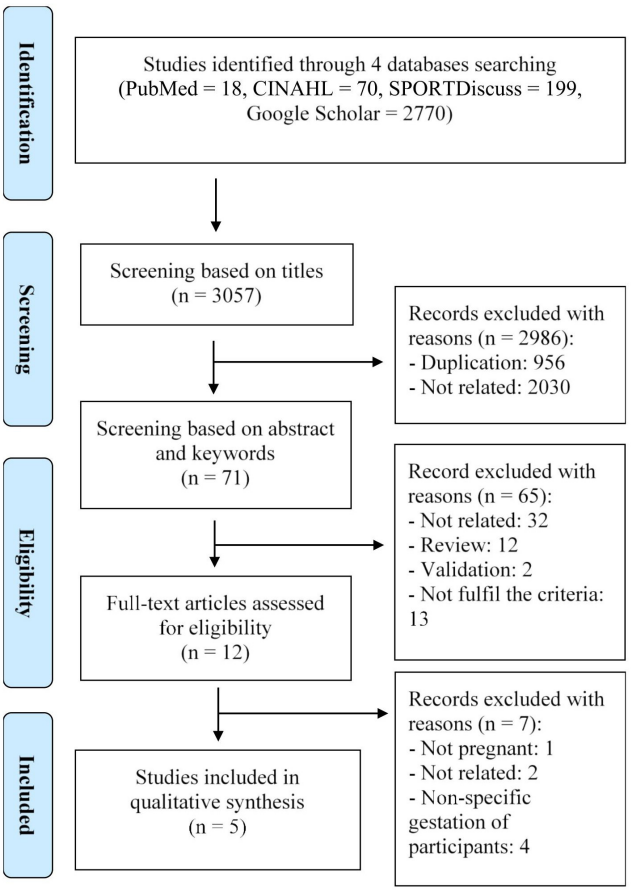


**Figure 1: Flow chart of the systematic review**

### Quality Assessment of The Study

For quality control, each of selected full-text articles was analysed by the author based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (23). This tool comprises of 34 items (sub-items included) to evaluate the individual study. Some of the items in the checklist (items 6a, 6b, 12d, 14c, 15) are only particular to certain study design which is case-control or cohort study. Each item in the article was documented as either 'adequately reported' or 'inadequately reported'. But, if an item was not relevant for the study design, it was scored as 'not applicable'. 'Not applicable' items were not counted to a total score. Only articles conformed to more than 70% of all the criteria would be included in data extraction. The summary of reported quality assessment is shown in Table I.

### Data Extraction

In this phase, information such as name of the author with publication year, location, study design (cross-sectional, case-control or cohort), statistical analysis, sample size, population sampling, gestation/trimesters, tool measured physical activity and finding (relative risk,

**Table I: Quality Assessment of Selected article based on STROBE checklist**

| Items | Authors | (Owe et al., 2009) | (Juhl et al., 2012) | (Padmapriya et al., 2015) | (Watson et al., 2017) | (Santo et. al, 2017) |
|---|---|---|---|---|---|---|
| | **Title and Abstract** | | | | | |
| 1a | Study design was described | Y (Cohort) | Y (Cohort) | Y (Cohort) | Y (Cohort) | Y (Cross Sectional) |
| 1b | Abstract: informative and balanced summary | Y | Y | Y | Y | Y |
| | **Introduction** | | | | | |
| 2 | Explain about background | Y | Y | Y | Y | Y |
| 3 | Specific objective | Y | Y | Y | Y | Y |
| | **Methods** | | | | | |
| 4 | Study design | Y | Y | Y | Y | Y |
| 5 | Setting including location, period of recruitment, data collection, follow-up and exposure | Y | Y | Y | Y | Y |
| *6a | Participant and selection criteria | Y | Y | Y | Y | NA |
| *6b | Matching | N | N | N | N | NA |
| 7 | Define variable | Y | Y | Y | Y | Y |
| 8 | Data Sources and measurement | Y | Y | Y | Y | Y |
| 9 | Method assess risk of bias | Y | Y | Y | Y | N |
| 10 | Explain on study size was created | Y | Y | N | Y | Y |
| 11 | Method on quantitative variable were categorized | Y | Y | Y | Y | Y |
| 12a | Statistical method | Y | Y | Y | Y | Y |
| 12b | Statistical method on interaction and measurement of subgroup | Y | Y | N | N | N |
| 12c | Missing data | Y | Y | Y | Y | Y |
| *12d | Follow-up, matching and sampling strategy | Y | Y | Y | Y | NA |
| 12e | Sensitivity analysis | N | N | N | N | N |
| | **Result** | | | | | |
| 13a | Number of participants at each stage of study | Y | Y | Y | Y | Y |
| 13b | Reason for non-participants | Y | Y | Y | Y | Y |
| 13c | Flow diagram used | Y | N | Y | Y | N |
| 14a | Descriptive statistic | Y | Y | Y | Y | Y |
| 14b | Number of missing data | Y | Y | Y | Y | Y |
| *14c | Follow-up time | Y | Y | Y | Y | NA |
| *15 | Outcome data | Y | Y | Y | Y | NA |
| 16a | Main result | Y | Y | Y | Y | Y |
| 16b | Category boundaries reported | Y | Y | Y | Y | Y |
| 16c | Translating relative risk into absolute risk | Y | Y | Y | Y | Y |
| 17 | Additional analysis | N | N | N | N | Y |
| 18 | Summary key result | Y | Y | Y | N | Y |
| 19 | Limitation | Y | Y | Y | Y | Y |
| 20 | Overall interpretation | Y | Y | Y | Y | Y |
| 21 | Generalizability | N | N | N | N | N |
| 22 | Funding and role of funder | Y | Y | Y | Y | Y |
| | **Scoring** | **88.2%** | **85.3%** | **83.4%** | **83.4%** | **82.8%** |

*Applicable for case-control and cohort study design; Y (adequate); N (inadequate); NA (not applicable)

risk ratio or β Coefficient and p-value) were extracted using a standardized table. Then, the studies were arranged according to the year of publication. The summary of extracted information is depicted in Table II. However, a meta-analysis was not done due to the heterogeneity of a study population, a tool used for measuring the physical activity, and the outcome of the study.

## RESULT AND DISCUSSION

### Study Selection

Overall, a total of five studies were included for the final assessment on predictors of physical inactivity among antenatal women. Most of predictors were aroused from cohort study design. This shows that the outcome generated from high ranked observational studies made the predictors stronger and more reliable. Therefore, the predictors can be interpreted as temporally related to the PA among antenatal women and successful future intervention can be implemented. All these studies were published between 2009 and 2018. The predictors of physical inactivity include lifestyle, health, sociodemographic and socioeconomic factors. The summary of the predictors of physical inactivity is depicted in Table III.

### Characteristics of The Selected Studies

The characteristics of the selected studies are displayed in Table II. Based on this assessment, all studies were

**Table II: Data extraction from the selected study**

| Author (Year) | Location | Study Design/ Statistical Analysis | Gestation/ Trimester | Tool measured physical activity | Dependent Variable | AOR/β Coefficient for physically inactive pregnant women | |
|---|---|---|---|---|---|---|---|
| | | | | | | 2nd trimester | 3rd trimester |
| (Owe, Nystad, & Bш, 2009) | Norway | Cohort/ Multiple logistic regression analysis | 34 508 pregnancies at week 17 and 30 | Self-reported physical activity (participating recreational activities at least three times a week) | Regular exercise | • Pre-pregnancy BMI (overweight): AOR = 0.74 (0.69 – 0.79)<br>• Pre-pregnancy BMI (Obese I): AOR = 0.76 (0.68 – 0.86)<br>• Pre-pregnancy BMI (Obese II): AOR = 0.77 (0.63 – 0.94)<br>• Parity (≥ 1): AOR = 0.76 (0.72 – 0.81)<br>• Taking sick-leave: AOR = 0.68 (0.63 – 0.74)<br>• Pelvic girdle pain: AOR = 0.83 (0.76 – 0.91)<br>• Nausea: AOR = 0.78 (0.73 – 0.83)<br>• Multiple pregnancy: AOR = 0.64 (0.51 – 0.81) | • Pre-pregnancy BMI (overweight): AOR = 0.64 (0.60 –0 .69)<br>• Pre-pregnancy BMI (Obese I): AOR = 0.56 (0.49 – 0.64)<br>• Pre-pregnancy BMI (Obese II): AOR = 0.50 (0.40 – 0.63)<br>• Parity (≥ 1): AOR = 0.65 (0.61 – 0.69)<br>• Taking sick-leave: AOR = 0.75 (0.71 – 0.80)<br>• Pelvic girdle pain: AOR = 0.73 (0.69 – 0.78)<br>• Musculoskeletal pain: AOR = 0.94 (0.88 – 0.99)<br>• Uterine Contraction: AOR = 0.91 (0.86 – 0.99)<br>• Multiple pregnancy: AOR = 0.38 (0.28 – 0.51) |
| (Juhl, Madsen, Andersen, Andersen, & Olsen, 2012) | Denmark | Cohort / Multiple logistic regression analysis | 88 200 singleton pregnancies at week 16 and 30 | Self-reported physical activity (Danish Board of Health guidelines) | Regular exercise (more than 3 times per week) | • Parity (1): AOR = 0.56 (0.53 – 0.59)<br>• Parity (≥2): AOR = 0.48 (0.44 – 0.51)<br>• Normal self-rated health: AOR = 0.67 (0.64 – 0.71)<br>• Less good self-rated health: AOR = 0.57 (0.50 – 0.66)<br>• Less healthy diet: AOR = 0.57 (0.53 – 0.62)<br>• Smoking 1 - <10 sticks/day: AOR = 0.81 (0.74 – 0.89)<br>• Smoking ≥ 10 sticks/day: AOR = 0.63 (0.56 – 0.71)<br>• Pre-pregnancy BMI (Overweight): AOR = 0.93 (0.88 – 0.99)<br>• Pre-pregnancy BMI (Obese 1): AOR = 0.90 (0.82 – 0.98)<br>• Received fertility treatment: AOR = 0.85 (0.78 – 0.92) | • Parity (1): AOR = 0.54 (0.51 – 0.58)<br>• Normal self-rated health: AOR = 0.65 (0.61 – 0.69)<br>• Less good self-rated health: AOR = 0.60 (0.50 – 0.72)<br>• Less healthy diet: AOR = 0.54 (0.50 – 0.60)<br>• Smoking 1 - <10 sticks/ day: AOR = 0.83 (0.74 – 0.93)<br>• Smoking ≥ 10 sticks/day: AOR = 0.62 (0.53 – 0.71)<br>• Pre-pregnancy BMI (Overweight): AOR = 0.82 (0.76 – 0.89)<br>• Received fertility treatment: AOR = 0.89 (0.80 – 0.98) |
| (Padmapriya et al., 2015) | Singapore | Cohort / Multiple logistic regression analysis | 1171 multi-ethnic (Malay, Chinese, and Indian) pregnant women at week 26 – 28 | International Physical Activity Questionnaire (IPAQ) short form | Sedentary behaviour (Reduction in physical activity ≥60 MET-min/ week and sitting time) | • Medium household income: AOR = 2.1 (1.3 – 3.5)<br>• High household income: AOR = 3.1 (1.8 – 5.4)<br>• Moderate/severe nausea/ vomiting during pregnancy: AOR = 1.7 (1.2 – 2.4) | |
| (Watson, Van Poppel, Jones, Norris, & Mickles-field, 2017) | South Africa | Cohort / Multiple linear regression analysis | 332 Singleton pregnant women at week 14 – 8 and 29 – 33 | Global Physical Activity Questionnaire (GPAQ) | Physically activity (work, transport, recreation) | • Married: β = - 0.12 (p = 0.03) | • Married: β = -0.17 (p = 0.01) |
| (Santo, Forbes, Oken, & Belfort, 2017 | North Carolina, Colorado & Oklahoma | Cross Sectional / Multiple logistic regression analysis | 2669 pregnant women from North Carolina and Colorado; 1584 pregnant women from Oklahoma at 3rd Trimesters | Colorado & Oklahoma Physical Activity Questionnaire | Physically activity (≥ 5days/ week and adhere to ACOG recommendation) | | • Pre-pregnancy physical activity (< 1 day/ week): AOR = 0.10 (0.04 – 0.30) |

carried out in high-income countries, namely Norway, Denmark, Singapore, South Africa and the United States (19,21–24). Therefore, the relevancy of the review is limited to high-income countries. In relation to participants, one study recruited multiples ethnicity group of participants which was a study done in Singapore (Malay, Chinese and India) (19). Singapore, the only Asian country on the list, measured physical inactivity and sedentary behaviour as a dependent variable.

The number of pregnancies of participants also play an essential role to determine the risk of the pregnancy. Pregnancies with more than one foetus warrant a health risk. Multiple pregnancies (≥2) are more physically inactive compared to single pregnancies. In this review, two studies reported only singleton pregnancies while the other three were mixed population that included both singleton and multiple pregnancies (22,24). The heterogeneity of the participants restricted the generalizability of the finding to other pregnant women.

Entirely, three studies measured physical activity in both second and third trimester, one measured in second trimester and another studied in third trimester only. There are little studies done among early pregnancy participants. This may be due to the major changes of the body that restricts pregnant women from becoming active at the earlier phase of pregnancy (7,25).

For the analysis, a multiple logistic regression was done in four studies to determine the predictors of physical inactivity and the result introduced as adjusted odds ratios (aOR) with 95% confidence intervals (95% CI), while only one study had multiple linear regression as their statistical analysis (26).

**Difference Tool in Measuring Physical Activity**

Validated tool or instrument is crucial in determining the accuracy of the variables. In this case, physical activity can be measured either through objective or subjective methods. The objective methods include accelerator and doubly labelled water devices. This method is more accurate as compared to subjective methods like questionnaire or survey. However, this method is expensive and difficult to operate. In this review, two studies used international validated questionnaire, which are GPAQ and IPAQ (19,22). This questionnaire is widely used for an epidemiological study. While the other three studies used a standardized questionnaire that is used for their own countries (21,23,24). Therefore, there is a possibility of biases in the measurement of physical activity levels among the participants. The physical activity information tends to be varied from one study to another study that made them incomparable as they used a different tool. On top of that, the likelihood of recall bias could be raised as all selected articles used questionnaires to measure physical activity. Consequently, information bias might occur.

**Predictors of Physical Inactivity**

The primary purpose of this article is to conduct a qualitative assessment on physical inactivity predictors among antenatal women, particularly at difference trimesters, in contrast to recent systematic review where the outcome yielded at non-specific gestation incorporating with attitude, enabler and barrier factors of physical activity among antenatal women (27). Besides that, a previous systematic review of sedentary behaviour highlights the prevalence of sedentarism and its impact on pregnancy (28). Having a sedentary lifestyle and being physically inactive are two different things; being inactive physically means not meeting the physical activity guideline while sedentary means sitting or lying down for a long period (29). Hence, sedentary lifestyle falls under the category of physical inactivity. Based on this review, the predictors of physical inactivity are further divided in to three main factors which are lifestyle, health, sociodemographic and socioeconomic factors. The summary of the predictors Besides in Table III.

**Sociodemographic and socioeconomic factors**

In this study, it is predicted that pregnant women will be physically inactive at second and third trimester if (1) their BMI indicates overweight, obese I and obese II before getting pregnant, (2) having at least one children as well as married as their marital status (22–24). Whilst, household income and physical inactive pre-pregnancy were predictors at second and third trimesters respectively (19,21). Pregnancy causes multiple physiological and anatomical changes, particularly during the second half of the pregnancy. These include hormonal changes and weight gain which can cause overweight or obese pregnant women to become even heavier as well as cause laxity of the muscles and ligaments. These conditions lead to difficulty in movements and tendency to injury, especially at the late pregnancy phase as the foetus grows prominently. (4,30–32). Due to these changes, it is likely that inactiveness increases during the third trimester (3,30,32,33). A randomised controlled trial study done among 399 Finnish antenatal women revealed that pregnant women who meet the recommendation prior to pregnancy will maintain and increase their PA during antenatal period (34). It might be due to the early adaption of the body towards any anatomical and physiological changes occur during pregnancy. Therefore, physical activity status prior to pregnancy plays a vital role in establishing the level of PA. On top of that, changes of physical activity is also influenced by the number of children as women demand for child care in order for them to perform physical activity (35).

**Table III: Summary of physical inactive predictors among antenatal women**

| Factors | Authors | Finding | |
|---|---|---|---|
| | | Second Trimesters | Third Trimesters |
| **Sociodemographic and socioeconomic factors** | Juhl et al., 2012; Owe et al., 2009; Watson et al., 2017 | Pre-pregnancy BMI (overweight, obese I and Obese II), parity (≥1), marital status | |
| | Padmapriya et al., 2015; Santo et al., 2017 | • Household income (Singapore dollars ≥6000) | • Pre-pregnancy physical activity status (< 1 day/ week) |
| **Lifestyle factors** | Juhl et al., 2012 | Smoking (≥1 stick per day), taking less healthy diet | |
| **Health related factors** | Juhl et al., 2012; Owe et al., 2009 | Multiple pregnancy, taking sick-leave, pelvic girdle pain, normal/ less self-rated health, received fertility treatment | |
| | Owe et al., 2009; Padmapriya et al., 2015 | • Early symptom of pregnancy (nausea/vomiting), | • Musculoskeletal pain, uterine contraction, |

**Lifestyle factors**

Additionally, this systematic review revealed that lifestyle factors, namely smoking at least a stick per day and eating the unhealthy diet such as high intake of fat and carbohydrate meal, were the predictors of physical inactivity at second and third trimesters (24). This might be due to the lack of awareness on healthy lifestyle among pregnant women. As mentioned before, pregnant women will experience a lot of physiological and anatomical changes. These include changes to multiple organs in the body such as cardiorespiratory system, what more of those who smoke (4,30,36). Pregnancy may also be accompanied by a subjective feeling of breathlessness that restricts them to perform physical activity (30). In addition, diet intake with high content in fat, free sugars, and salt is significantly associated with overweight, obesity, and other health complications that restrict the individual from becoming active (37,38).

**Health-related factors**

Despite sociodemographic, socioeconomic and lifestyle factors, this review also revealed the important of health-related factors as a predictor of physical inactivity among pregnant women. Multiple pregnancies, taking sick-leave, pelvic girdle pain, normal or less self-rated health, reception of fertility treatment, symptoms of early pregnancy, musculoskeletal pain and uterine contraction were the predictors of physical inactivity. A condition of pregnancy involving fertility treatment also affects involvement in physical activities to prevent complications such as preterm delivery (4,39,40). Moreover, moderate to severe form of nausea and vomiting during the early phase of pregnancy cause pregnant women to feel lethargic and unable to do any form of activity, even daily routines. Although these symptoms are common in initial trimester but they can persist up to the mid second trimesters (25,30,41). In addition, as the foetus grow, the pregnant women will experience pelvic girdle pain as well as musculoskeletal pain that prevents them from doing any physical activity, especially during the third trimester. On top of that, a "Braxton Hicks" contraction is a common occurrence at the third trimester as it is a part of the delivery preparation. At this state, expectant mothers are especially uncomfortable particularly during active state as the contraction may become stronger (7,30,36). The American College Obstetrics and Gynaecology (ACOG) as well as the American College of Sport Medicine (ACSM) recommended that all pregnant women should engage in moderate PA , approved by the medical experts, for the benefit of the mothers and the foetuses to prevent from any related complications (3–5).

**Limitation**

This review warrants a limitation. One of the limitations is the search strategy that only selects original English published research articles between the years of 2007 and 2018. Thus, the possibility of selection bias is possible in this review.

In addition, the other component that limits the quality of the systematic review is the quality of research methodology. Most of the articles do not clearly state the sample size calculation as well as the sensitivity analysis. Sensitivity analysis performed to clarify on how variable values impact a selected dependent variable beneath a given set of assumptions. This is important to evaluate how sensitive the output, physical activity, is with any changes in the independent variables.

On the other hand, the measurement bias on physical activity also contributes to the limitation of this systematic review. The reviewed articles measured physical activity using different questionnaires with different measurements for physical activity. The variability of the measurements is due to the availability of the valid and reliable tools that are suitable with the culture and population of the location of study.

## CONCLUSION

As a conclusion, these predictors give useful information on why pregnant women do not participate in physical activity during pregnancy. The predictors are sociodemographic, socioeconomic, lifestyle and health-related factors. By identifying these factors, healthcare workers in the future can implement these information and focus on the target population to ensure the success of the programme.

However, the heterogeneity in the literature suggests future research need to use strong methodology, ideally with objective measures for quantifying physical activity. Besides that, most of the studies involving this subject is done in Western settings, thus, it is highly recommend that such review is conducted in the Asian setting.

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