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Physical Activity and Body Mass Index in Relation to Infertility in Women

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ABSTRACT:

BACKGROUND: Infertility is a global social issue, and reproductive health is a priority in global health. This review aimed to study the relation between physical activity (PA) and infertility in non-obese or non-overweight women.

METHODS: We used search strategies in the National Library of Medicine database including the PubMed database to October 2019 to find articles related to women and fertility, infertility, exercise, PA, pregnancy rate, live births, fecundability, and conception. Only cohort studies or randomized controlled trials in English were chosen for review that included outcomes directly related to becoming pregnant. We selected studies in which the participants were categorized by low or high body mass index (BMI).

RESULTS: We found 6 papers meeting our criteria. In the association between PA and outcome, vigorous PA in women with low BMI resulted in both positive and negative effects that were weaker than those in women with high BMI. Among women with low BMI, moderate PA was weakly but positively associated with outcome whereas walking was not.

CONCLUSION: We observed some trends and slight difference between outcomes of women with low versus high BMI. There are only a few studies on infertile women with low BMI, and further investigation is warranted.

Keywords: physical activity; exercise; infertility; fertility; pregnant, body mass index

1. Introduction

Infertility is a global social issue [1,2], and reproductive health is a priority problem in global health [2]. Approximately one-eighth of couples of childbearing age faces this problem [3]. The causes vary from person to person. Many lifestyle factors such as nutrition, psychological stress, and environmental and occupational exposures can have substantial effects on fertility [4]. Body mass index (BMI) is also a factor in infertility [4,5].

Previous studies suggested that an extremely low or high BMI might be a cause of infertility [4,6,7]. In addition, other previous studies also suggested that physical activity (PA) in women with high BMI could improve their ability to become pregnant [8-10]. Infertility is a problem in Japan, with 18.2% of couples undergoing infertility treatment in their first marriage [11]. In contrast to the worldwide problem of obesity, in Japan, the number of women with low BMI is increasing. The

proportion of women with a BMI below 18.5 kg/m² was 21.7% among 20–29-year-olds, whereas that of women with a high BMI (≥ 25.0 kg/m²) was 5.7% [12]. The effect of PA on becoming pregnant in women with low BMI remains unclear. We hypothesized that in women with low BMI, as in women with high BMI, PA would be related to the ability to become pregnant. Therefore, we aimed to investigate the relationship between PA and pregnancy in women with low BMI.

2. Materials and Methods

2.1. Data sources and search strategies

This review was conducted in accordance with the PRISMA statement [13]. We applied search strategies to one database, the National Library of Medicine database including the PubMed database, in which searching was completed in October 2019. We searched using terms related to women and fertility, infertility, exercise, PA, pregnancy rate, live births, fecundability, and conception. Next, among the articles returned from this search, we checked the titles, abstracts, and full papers in turn. When we could not read a full manuscript using the database, we requested the author to provide us with it. We also checked the references of the reviews found by our search and chose papers based on these references.

2.2. Study selection

We chose only English-language studies for inclusion if they reported data on exercise or PA for women. The World Health Organization stratifies BMI categories into underweight (< 18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), and obese (> 30.0 kg/m²) [14]. In the present review, women with BMI below 25.0 kg/m² were defined as having low BMI, and those with BMI ≥ 25.0 kg/m² were defined as having high BMI. We selected the studies in which the participants were categorized by low BMI or high BMI to compare the association between PA and outcome.

2.3. Outcomes

We defined primary outcome as those directly related to becoming pregnant.

2.4. Classification of the association between PA and outcomes

The association between PA and outcomes (e.g., negative association or slightly negative association) and the intensity of the association (e.g., weak or strong) were based on the opinion of each study's authors.

3. Results

3.1. Characteristics

We found 468 papers that included the following key words: pregnancy rate ($n = 44$), live births ($n = 22$), fecundability ($n = 276$), and conception ($n = 40$). We excluded 391 of these 468 papers on the basis of their titles, which included rat model, pregnancy-related pain, and guideline, and overlapping papers. Next, we excluded 73 papers after reading their abstracts and full papers. We chose 4 papers along with 2 papers [15,16] obtained from references in the paper by Lee [9]. Finally, 6 papers were included in this review [7,14–18] (Figure 1, Table 1).

We eventually defined primary outcome as the following outcomes: fecundability [14,17,18] and primary in vitro fertilization (IVF) outcomes (e.g., successful live birth and four points of cycle failure: cycle cancellation, failed fertilization, implantation, and pregnancy loss) [15], and relative risk of ovulatory disorder [7,16]. A summary of the reviews is shown in Table 1. In the present review, the outcomes were not unified because the characteristics or backgrounds of the participants differed from each other.

In addition, we assigned PA type to three categories: Vigorous PA, which included running, fast cycling, aerobics, gymnastics, swimming, weight training, and hard physical effort that makes one

breathe much harder than normal (6.0 metabolic equivalents/h); Moderate PA, which included leisurely cycling, golfing, gardening, yoga, and effort that makes one breathe somewhat harder than normal; and Walking.

The age of the participants ranged from 18 to 45 years. These studies included participants in Denmark [17] and the United States [7,14,16-18]. The BMI was calculated using self-reported height and weight measurements by each study's authors. Four studies [14,15,17,18] included women planning to become pregnant, and 2 studies [7,16] included women not planning to become pregnant. The participants in 2 studies [14,17] had been trying to conceive for less than 6 cycles at study entry.

The follow-up period ranged mostly from 8 weeks to 12 months for fecundability [14,17,18] and mostly from 6 to 8 years for relative risk of ovulatory disorder [7,16], which was not involved in the determination of IVF outcome [15]. Outcomes were based on responses to questionnaires answered by the participants.

Participants in 2 studies [14,17] were "general woman" because the participants were recruited online. Neither the participants defined as general women [14,17] nor those prior to beginning IVF [15] had ever undergone infertility treatment. Russo et al. [18] reported women with a history of 1-2 prior pregnancy losses and those who had taken low-dose aspirin, which was tested and confirmed not to effect fecundability in the study. Morris et al. [15] researched whether PA performed before the first cycle of IVF affected IVF outcomes. Two studies [7,16] researched the association between PA and the relative risk of ovulatory disorder. In the Morris et al., study [15] only, we altered the name for intensity of PA from the "cardiovascular" group to the "vigorous" group so as to arrange it among several other categories. A finding of "positive association" or "negative association" or "no association" indicated a "good effect" or "bad influence" or "no association" for becoming pregnant.

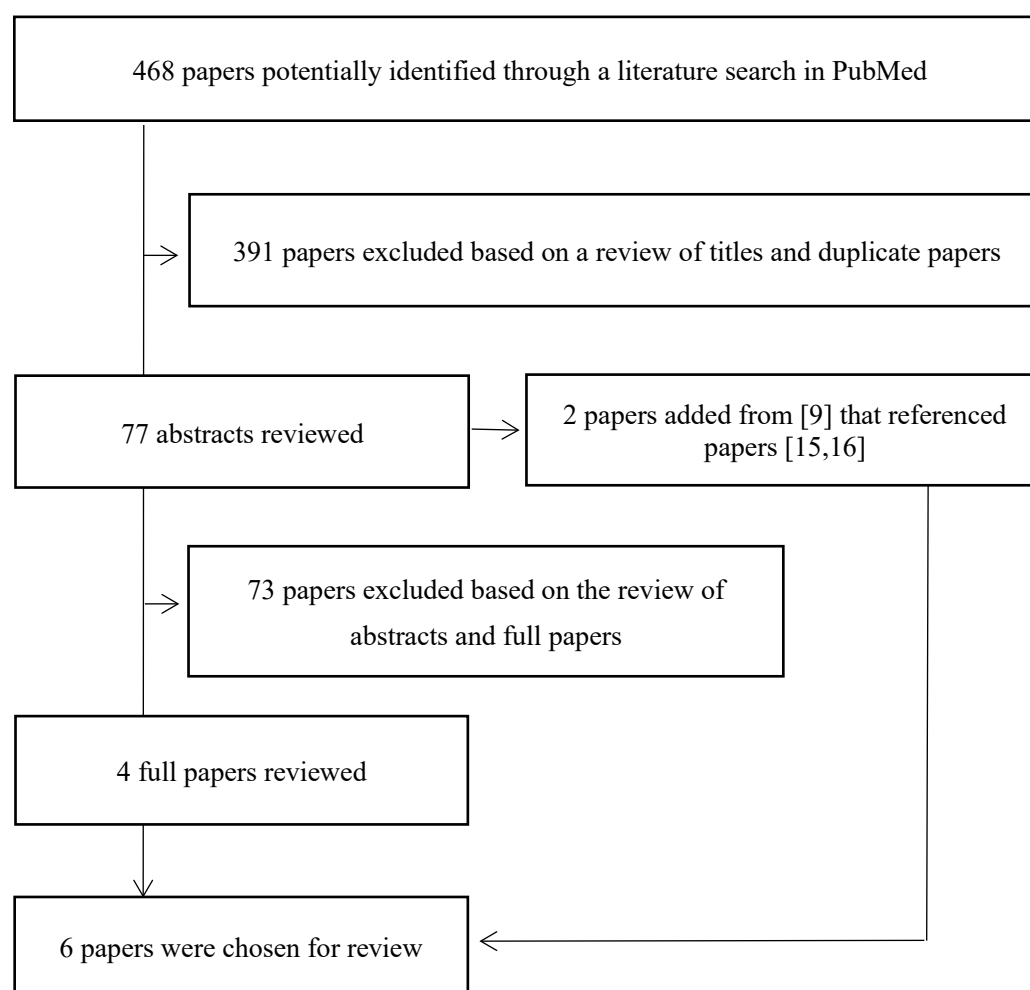


Figure 1. Study flow diagram.

Table 1. Summaries of physical assessment and outcomes.

Source	Population (sample)	Category of physical assessment	Outcome	Association	
				Low body mass index	High body mass index
Wise et al. [17]	General (n = 3628)	Vigorous		Negative association	Weakly positive association
		Moderate		Weakly positive association	Weakly positive association
McKinnon et al. [14]	General (n = 2062)	Vigorous	Fecund ability	No association	Positive association
		Moderate		Weakly positive association	
Russo et al. [18]	History of pregnancy loss (n = 1128)	Vigorous		Positive association	
		Moderate		No association	
		Walking		No association	Positive association
Morris et al. [15]	In vitro fertilization (n = 2232)	Walking	In vitro fertilization outcomes	No association	
		Vigorous		Negative association	
Chavarro et al. [16]	Ovulatory disorder (n = 416)	Vigorous	Relative risks for ovulatory infertility	No association	
Rich-Edwards et al. [7])	Ovulatory disorder (n = 830)	Vigorous		Positive association	

3.2. Association between outcome and PA type in women with low or high BMI

To grasp the overall association between PA and outcome, we assigned findings of “no association” to the “no association group” and findings of “weakly positive association” and “positive association” to the “positive association group” (Table 2).

Table 2. Association between physical activity and outcome.

BMI	Intensity of PA	Association			
		Negative association	No association group	Positive association group	
		Negative	No association	Weakly positive association	Positive association
Low	Vigorous	2 (1: IVF)	2 (1: ovulatory)		2 (1: ovulatory)
	Moderate		1	2	
	Walking		2 (1: IVF)		
	Total	2	5	4	
High	Vigorous	1 (IVF)	1: ovulatory	1	3 (1: ovulatory)
	Moderate		1	2	
	Walking		1: IVF		1
	Total	1	3	7	

BMI = body mass index; PA = physical activity, IVF = in vitro fertilization.

Among women with low BMI, vigorous PA was negatively associated with outcome in 2 analyses [15,17], not related to outcome in 2 analyses [14,16], and positively associated with outcome in 2 analyses [7,18]. None of the studies reported a negative association with moderate PA, whereas 2 analysis reported a positive association [14, 17]. Among women with high BMI, vigorous PA was positively associated with outcome in 4 analyses [7,14,17,18], and no study reported a negative association with moderate PA. Walking was reported to have a positive association with outcome in 1 analysis [18].

3.3. Association between PA and participant type

Among general participants with low BMI, 1 analysis [17] reported that vigorous PA was negatively associated with outcome, whereas among participants with high BMI, 2 analyses [14,17] found a weakly positive association between PA and outcome. Among participants who had a history of pregnancy loss, only 1 analysis [18] showed vigorous PA to be positively associated with outcome regardless of BMI. Among participants preparing to undergo IVF treatment, vigorous PA was not associated with a good outcome for IVF, whereas walking had no relation to outcome regardless of BMI [15]. A positive association between the relative risk of ovulatory disorder and vigorous PA was shown in 1 analysis [7], whereas the other analyses indicated no association with outcome regardless of BMI.

4. Discussion

This is the first review, to our knowledge, to report an association between PA and the outcome of becoming pregnant in women with low BMI. We observed some trends and slight differences between women with low BMI and those with high BMI.

Among the women with low BMI, there was a tendency for vigorous PA to show an even spread from a negative association to a positive association. Regarding moderate PA, the present review is in agreement with previous studies that reported moderate PA to be positively associated with the outcome of becoming pregnant regardless of BMI [9].

4.1 Significance of the associations found in this review

This review showed a scattering of associations between PA and outcome. It is highly important to research these associations because for women, pregnancy is a major, biologically important life event, and its duration is limited. The risk of abortion or Down's syndrome increases with aging. Thus, when couples think they want a child, it is necessary for the woman to properly prepare the condition of her body. Stress and cigarettes are commonly known to be harmful to health in terms of infertility, and they also influence infertility. [19] However, it is not easy to determine suitable PA for becoming pregnant because of the complicated factors involved in infertility. Our review showed that PA performed at a higher strength level does not necessarily reduce infertility and might even have a negative influence on women with low BMI. Thus, we need to research the association between PA and women with low BMI in greater detail.

4.2. Association between suitable intensity or time of PA and participant type

The present review found that in terms of the relative risk of ovulatory disorder, PA was not harmful to women, and vigorous PA might improve the relative risk of ovulatory disorder regardless of BMI. Chavarro et al. [16] showed that vigorous PA for 30 min or more each day resulted in a slightly lower relative risk of ovulation regardless of BMI. This agreed with Hakimi et al. [20], who reported that vigorous PA for 30–60 min/day improved the risk of ovulatory infertility in women with high BMI. However, some studies that did not consider BMI reported that vigorous PA was associated with a reduced ability to become pregnant [9,21]. In addition, Hakimi et al. [20] also showed an increased risk of anovulation in women who engaged in extremely heavy exercise (>60 min/day).

From point of view of the general population, McKinnon et al. [14] reported that PA of ≥ 5 h/wk in women with high BMI showed a positive effect. However, among women with low BMI, there was no relation between PA and outcome. In women with a history of pregnancy loss, Russo et al. [18] reported walking (median 3 h/wk) by women with a high BMI was associated with positive outcome, whereas among women with a low BMI, walking ≥ 10 min at a time was not associated with outcome. Thus, the association between PA and outcome might differ according to each BMI level, and further detailed research is needed according to the performance of a suitable intensity or amount of PA. Morris et al. [15] reported that performing vigorous PA before undergoing IVF treatment led to a negative association with IVF outcomes. However, a limitation of their study was that they did not consider PA during IVF. In contrast, Best et al. [8] showed no association between exercise and the rate of conception following IVF in women with high BMI. In addition, a systematic review and meta-analysis of studies [12] indicated the possibility that PA may be as effective as other commonly used clinical treatments for improving reproductive health outcomes in women with high BMI. However, it is not clear whether PA has a positive effect on women with low BMI, and further studies will be needed along with improving outcomes of IVF.

4.3. Explanation and implications

As described earlier, Japan is facing the problem of an increasing number of underweight women. Oguri [22] reported that the young women at a certain university tended to have a lower than normal BMI. However, their rate of body fat was high compared to the rate of BMI in Japan. Thus, even though these women appear to be of standard weight or slightly lighter, their amount of body fat might be higher than the normal.

The amount of body fat relates to pregnancy and reproductive health [6], and it is thought that women should not carry too much or too little fat [1,6,23,24]. In this review, women with low BMI may include women with either high or low body fat, and this might have caused the range of outcomes in response to vigorous PA to extend from negative to positive associations. Therefore, the findings in the present review agreed with a previous study reporting that BMI is not suitable for measuring body fat and body composition [1], especially in women with low BMI as seen in many women in Japan.

Further, Loy et al. [1] previously reported that central adiposity in women was not associated with fecundability and found a relationship between fecundability and subcutaneous and total body fat in Asians (Chinese, Malay, India, and mixed races); a similar association between BMI and body fat is also seen in Japan.

Obesity affects sex hormone secretions and metabolism, and these effects are made worse by hyperinsulinemia [24], so improving insulin sensitivity is important for ovarian function [25]. PA improved insulin sensitivity and ovulatory function in women with high BMI [25].

However, it remains unclear whether PA positively affects fertility in women with low BMI and high body fat. In addition, although one report showed that the performance of PA in obese women is related to central adiposity [25], as mentioned above, Loy et al. [1] reported it to be associated with subcutaneous fat and body fat in Asian women. Nevertheless, women with low BMI and high body fat need to alter their diet to improve their body composition because the composition of one's diet has an impact on fertility [16].

A previous study [10] showed that PA may have the same effect as other commonly used clinical treatments for improving reproductive health outcomes in women with high BMI. However, it is not clear by what mechanisms PA improves fertility (e.g., weight loss, reduced body fat, improved metabolism, among others). For women with low BMI, PA may improve infertility as well as it does in women with high BMI. To determine this, further studies are needed to evaluate the effects of PA on becoming pregnant and its mechanisms in women with low BMI.

4.4. Limitations

Several of the studies we examined did not include statistical data. However, we needed to include these studies to report problems of women with low BMI. Further, only one database was searched by only one researcher. The study designs (e.g., characteristics of the participants, assessment criteria, follow-up periods, type or intensity of PA, and several outcomes) were not unified in the examined studies. Assessment of the questionnaires was not objective because of self-reporting. Because of this, the level of, or time spent on, PA may not be accurate. Therefore, the relationship between PA and pregnancy may be different when PA is tightly managed. We did not consider infertility problems related to the man, nor did we consider issues related to self-care or clinical treatment or other confounding factors such as smoking, alcohol use, or body fat.

5. Conclusions

Based on our analysis of the 6 studies reviewed, the association of PA with the outcome of becoming pregnant might differ between women with low BMI and those with high BMI. Vigorous PA in participants with low BMI had both positive and negative effects on outcome, and the effects were weaker than those on women with high BMI. Moderate PA showed a weakly positive relation to pregnancy. In women with low BMI, the amount of body fat might be associated with the results of PA. Because there are only a few previous studies on infertility in women with low BMI, further investigations into women with low BMI and the mechanism of PA are warranted to clarify their relationship to fertility.

Author Contributions: C.K., K.P.I., M.K., and Y.K. prepared the manuscript and researched the literature. C.K., K.P.I., M.K., and Y.K. conceived and designed the study. C.K. and M.K. collected the data. C.K. and Y.K. analyzed the data. C.K., K.P.I., M.K., and Y.K. drafted or critically revised the manuscript for important intellectual content.

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Conflicts of Interest: The authors declare no conflicts of interest.

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