The Estimation of Physical Activity among Australian Pregnant Women

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ABSTRACT

Background: Healthy women who participate in physical activity prior to pregnancy can safely continue to exercise during and after pregnancy. Exercise during pregnancy is associated with minimal risk and has demonstrated benefits such as reduced birth complications and enhanced postpartum quality of life. The aim of this study is to identify the level of physical activity before, during, and after pregnancy and to investigate changes in physical activity across these periods.

Methods: This study was designed to examine levels of physical activity before, during pregnancy, and after pregnancy. Pregnant women were required to self-report their level of physical activity prior to pregnancy, during the first, second, and third trimesters, and after pregnancy. This study also examined changes in physical activity before, during each trimester, and after birth. The Active Australia Survey was utilized to assess levels of physical activity. Approximately 200 healthy pregnant women were

recruited from the Royal Hospital for Women, Randwick, Sydney, and Wollongong Hospital, Wollongong, NSW, Australia. Data were analyzed using descriptive statistics; a one-way repeated-measures ANOVA was conducted to evaluate changes in physical activity.

Results: Levels of physical activity were higher before pregnancy compared with various points during pregnancy; however, they increased significantly after pregnancy. Walking quickly was the most common activity and made the largest contribution to energy expenditure across all stages of the study.

Conclusion: Healthy women can maintain moderate physical activity during pregnancy. Further investigation into the reasons for reduced levels of physical activity during pregnancy is required.

KEYWORDS:

Healthy women, pregnancy, trimesters, physical activity

Introduction

The Australian physical-activity guidelines recommend that pregnant women without exercise contraindications or medical complications can safely continue to participate in physical activity. The present recommendation indicates that pregnant women should be involved in 30 minutes a day or more of moderate exercise for at least three days, or most days of the week (American College of Obstetricians & Gynecologists, 2002; Department of Health, 2004; Health Human Services., 2008). However, pregnant women should avoid activities that involve high physical contact and have a potential risk of falling.

Research into measuring the predictors of meeting minimum levels of physical activity among pregnant women is limited. Studies that have examined physical activity levels

during pregnancy consist of only leisure-time physical activity (Cheung et al., 2007; Duncombe et al., 2007a; Wilkinson et al., 2009). However, the only existing study that has looked at achieving the recommended physical activity of 30 minutes of moderate intensity on most days of the week across trimesters was conducted by Wilkinson et al. (2009). Furthermore, 33% of pregnant women were observed to meet the minimum level of recommended physical activity (Wilkinson et al., 2009). However, Wilkinson et al. (2009) also sampled women with a mean stage of gestation of 19.4 weeks. Stage of gestation is an important consideration, as physical activity levels have been reported to decline by 40% in the third trimester (Duncombe et al., 2007). The study did not include occupational activities and included only strong household and gardening activities. An additional limitation of the study was collecting data over only one point of pregnancy.

Two Australian studies (Duncombe et al., 2007; Sui et al., 2013) have assessed levels of participation in physical activity during trimesters. Of the two, Duncombe et al. (2007) investigated self-reported physical activity and beliefs regarding the safety of exercise in 158 women. Physical activity was reported during the first (16–23 weeks of gestation), second (24–31 weeks of gestation), and third (32–38 weeks of gestation) trimesters. Results showed that 57.9% of participants engaged in regular physical activity pre-pregnancy, while 27.6% exercised irregularly, and 14.5% were described as performing none or extremely little exercise. There was a significant decrease in physical activity levels in the third trimester (34.3%) compared with the first trimester (46.3%). However, the study by Duncombe et al. (2007) was unclear about whether it included work and household activities, which contribute to the total amount of physical activity. Another limitation is that the study focused on women's beliefs about the safety of exercise, which does not necessarily reflect adherence to the Australian minimum physical activity guidelines. A more recent Australian investigation (Sui et al., 2013) assessed physical activity among overweight and obese women during

pregnancy and the postpartum period. Results showed that both overweight and obese women reported a gradual decrease in total physical activity between the first, second, and third trimesters; however, physical activity increased significantly at 4 months postpartum, although it remained lower than that reported in the first trimester. However, the sample for this study consisted of overweight and obese pregnant women, and it did not examine physical activity in relation to meeting Australian physical activity norms.

METHOD

Research Design

This investigation examined the level of self-reported physical activity in Australian pregnant women (Figure 1) at five different time points, retrospectively prior to pregnancy and prospectively at trimester one, two, three, and postpartum. These levels of activity were then compared with the recommended National Physical Activity Guidelines for Australians (Department of Health, 2004). This investigation also studied temporal changes in physical activity before and during each trimester of pregnancy and after birth. The longitudinal study was conducted at the Royal Hospital for Women, Randwick, Sydne,y and Wollongong Hospital, Wollongong, NSW, Australia.

The current investigation required women to complete a self-report questionnaire before pregnancy, during each trimester, and after birth. Furthermore, women were asked to complete the questionnaire at approximately the midpoint of each trimester. However, physical activity in the first trimester was typically sampled later. In the first trimester, participants were also asked retrospectively to complete the questionnaire regarding pre-pregnancy physical activity levels. Thus, each participant was asked to complete the survey five times at four different time points. The questionnaire was administered by a research midwife while participants attended the hospital antenatal clinic for routine visits. Several meetings were held with the antenatal clinic midwife to

inform her about the project, address any potential issues, and gain her support. All data were entered manually onto a computer and verified for accuracy at the time of entry and again two weeks later.

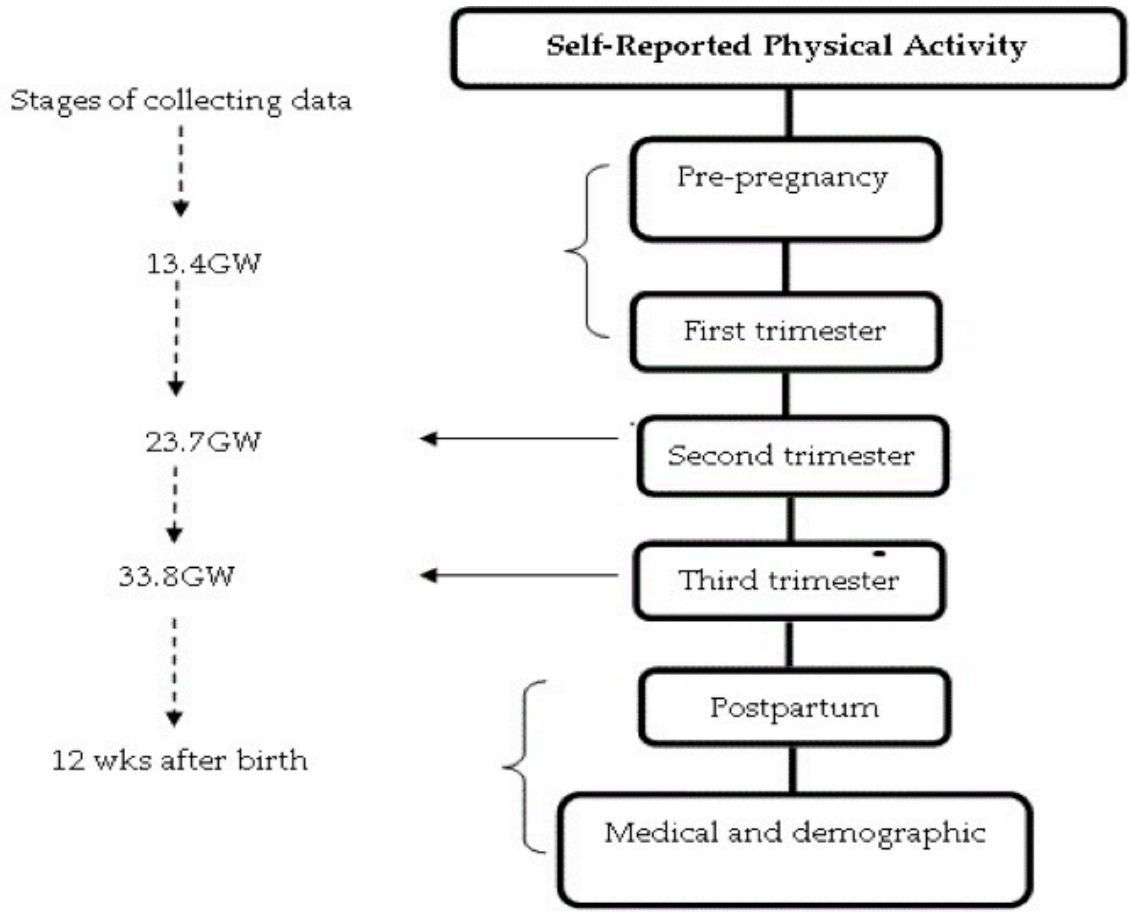

Figure 1 Research design of reported physical activity stages: GW (mean of gestational weeks)

Participants

Approximately 200 healthy pregnant women were recruited. Participants were eligible for the investigation if they had no medical or exercise contraindications. Initial recruitment involved distributing a flyer advertising the study's purpose and duration to potential participants. The midwife focused on identifying potentially eligible participants during their first prenatal care visit, approaching them in the waiting room,

and briefly explaining the study's aims and procedures. All subjects were asked to provide voluntary written informed consent prior to participating in the investigation. Participants with a minimum gestation time of 9 weeks were recruited. Participants in the first trimester were over 18 years old, had no history of previous gestational diabetes or type II diabetes, and had no other medical complications. Participants who had not visited the hospital within the first 20 weeks of pregnancy, those with multiple gestations, or those who could not complete the questionnaire in English were excluded from the investigation.

Assessment of physical activity

Physical activity domains were measured using a modified version of the Active Australia Survey. The Active Australia Survey provides normative data on Australian physical activity levels. The survey was validated based on the written format of the Active Australia Survey questions (Ainsworth et al., 2011; Brown et al., 2009). The resulting questionnaire was designed to measure a wide range of health-enhancing activities during pregnancy. The survey took approximately 10–20 minutes to complete. Total time and frequency of physical activity were recorded. Self-reported sociodemographic details such as height, weight, education level, and number of children were also collected. Body weight and height were self-reported, with body weight recorded in kilograms (kg) and height in centimeters (cm).

The Active Australia Survey

The Active Australia Survey typically uses computer-assisted telephone interviews to collect data on Australian physical activity levels. However, a recent study validated the written form of the Active Australia Survey questions (Ainsworth et al., 2011; Brown et al., 2009). Physical activity was measured using questions that asked about the frequency and duration of the following activities performed in the last week: brisk walking (for recreation, exercise, or transportation), moderate leisure activity (such as

social tennis, moderate exercise classes, recreational swimming, or dancing), vigorous leisure activity (that causes hard breathing, such as aerobics, vigorous cycling, running, or swimming), and vigorous household or garden chores (that cause hard breathing). Participants were asked to report only activities lasting 10 minutes or more. Activity scores were calculated as the sum of total weekly minutes spent in each activity. A metabolic equivalent value (MET) was assigned to each type of activity (Ainsworth et al., 2011; Brown et al., 2009). To calculate total energy expenditure in MET-hours per week, the time reported in minutes was divided by 60 using the following formula: (walking minutes × 3.0 METs × frequency ÷ 60) + (moderate leisure activity minutes × 4.0 METs × frequency ÷ 60) + (vigorous leisure activity minutes × 6.0 METs × frequency ÷ 60) + (vigorous household or garden chores minutes × 6.0 METs × frequency ÷ 60). This calculation has been shown to adequately measure activity (Brown et al., 2009; Burton & Turrell, 2000).

Demographic data

Self-reported demographic information, including height, pre-pregnancy weight, weight during each trimester, living situation, due date, and education level, was collected at the first prenatal visit. Living situation was assessed by asking, "Who lives with you?" (options included: partner/spouse; own children/under 5 years old; own children/5–12 years old; own children/13–17 years old; someone else's children/any age; parents; other adult). Education level was assessed by asking, "What is the highest qualification you have completed?" (options included: no formal qualifications; Year 10 or equivalent; Year 12 or equivalent; trade/apprenticeship; certificate/diploma; university degree; higher university degree). Weight and height before, during, and after pregnancy were self-reported at each data collection point. Body weight was recorded in kilograms (kg) and height in meters (m), and this data was used to calculate body mass index (BMI) (BMI = weight (kg) / height (m^2)). Participants were categorized

as normal weight (18.5 to 24.9), overweight (25 to 29.9), and obese (≥30) (Rasmussen & Yaktine, 2009; Weisman et al., 2009).

Ethical considerations

The research was approved and conducted in accordance with the Human Research Ethics Committee of the University of Wollongong, South Eastern Sydney, and Illawarra Area Health Service, New South Wales, Australia.

Data analysis

Descriptive statistics were calculated for both activity type and intensity across all study stages using the baseline data in SPSS version 21.0. A Pearson correlation was used to evaluate the relationship between pre-pregnancy and pregnancy body weight and total weekly MET hours during pregnancy. A one-way ANOVA and logistic regression were used to examine correlations between demographic data (education level and number of children) and total weekly energy expenditure in MET hours. To assess changes in physical activity indices over time, a repeated-measures ANOVA was used for normally distributed physical activity variables to assess changes in physical activity patterns during pregnancy. An alpha level of 0.05 was set to determine statistical significance (two-tailed tests were used).

Information from the physical activity items was used to calculate the amount of physical activity and, consequently, to present the total average weekly energy expenditure in MET-hours of physical activity performed.

Results

The results present the sociodemographic characteristics of the participants. They also present physical activity data collected using the Active Australia Survey, including information on adherence to the National Physical Activity Guidelines. Additionally,

the results show the number of women who were followed across pre-pregnancy, each trimester, and the postpartum period.

Participants' demographic characteristics

A total of seven hundred and forty (740) surveys were completed by 200 pregnant women across the five stages of the investigation: pre-pregnancy, during each trimester, and postpartum. The overall response rate was 74%. The number of respondents at each stage was as follows: 200 pre-pregnancy, 191 in the first trimester, 156 in the second trimester, 100 in the third trimester, and 93 postpartum. Approximately 9% of these women developed gestational diabetes. Forty-four (16.4%) participants withdrew from the study for various reasons, such as moving, transferring to another hospital, or relocating abroad.

Table 1 shows the educational background of the participants. The majority (57.5%; n=95) had completed tertiary education; of these, 39.5% had attained a bachelor's degree and 18% a higher university degree. Almost 24.5% of participants had a certificate or diploma. Approximately 9.5% of women had completed Year 12, 8.5% had completed Year 10 or equivalent, and only three participants had no formal education.

Table 1 Participants' highest qualification obtained

Characteristics	N	Proportion (%)
Education completed:		
Year 10	17	8.5
Year 12	19	9.5
Trade	10	5
Diploma	39	19.5
University	79	39.5
Higher degree	36	18

Notes: women's characteristics were taken prior to the pregnancy stage (n=200).

A multiple-response analysis was conducted to determine the frequency and proportion of each response, considering both the total number of responses and the number of individual respondents (Table 2). The results showed that the majority of participants (62%) lived with a partner or spouse, 21.1% had children under five years old, and 5.9% had children between 5 and 12 years old. Only 4% lived with their parents, and 4% had other adults living with them.

Table 2 Proportion of people living with the participants

People living with participants	Responses N	Percent (%)	Percent of cases
Partner	188	62	95.9
Children under 5y	67	21.1	34.2
Children 5-12	18	5.9	9.2
Children 13-17	4	1.3	2
Someone children	2	0.7	1
Parents	12	4	6.1
Other adults	12	4	6.1
Total	303	100%	154.6

Notes: Data on women's characteristics were collected at the pre-pregnancy stage (n=200). The "percent of responses" indicates the percentage of total responses within each category, while the "percent of cases" indicates the percentage of respondents who selected each category.

Mean energy expenditure was reported to be significantly ($p < 0.05$) higher during pre-pregnancy than in the first and third trimesters. In addition, energy expenditure (Figure 2) was 28%, 13.8 ±13.2 MET-h.wk^{-1} prior to pregnancy compared to 17%, 8.1 ±9.6 MET-h.wk^{-1} in the first trimester, 20%, 9.5 ±9.2 MET-h.wk^{-1} in the second trimester and 15%, 7.1 ±7.1 MET-h.wk^{-1} in the third, but significantly higher in postpartum figure of 21%, 10.1 ±8.2 MET-h.wk^{-1}.

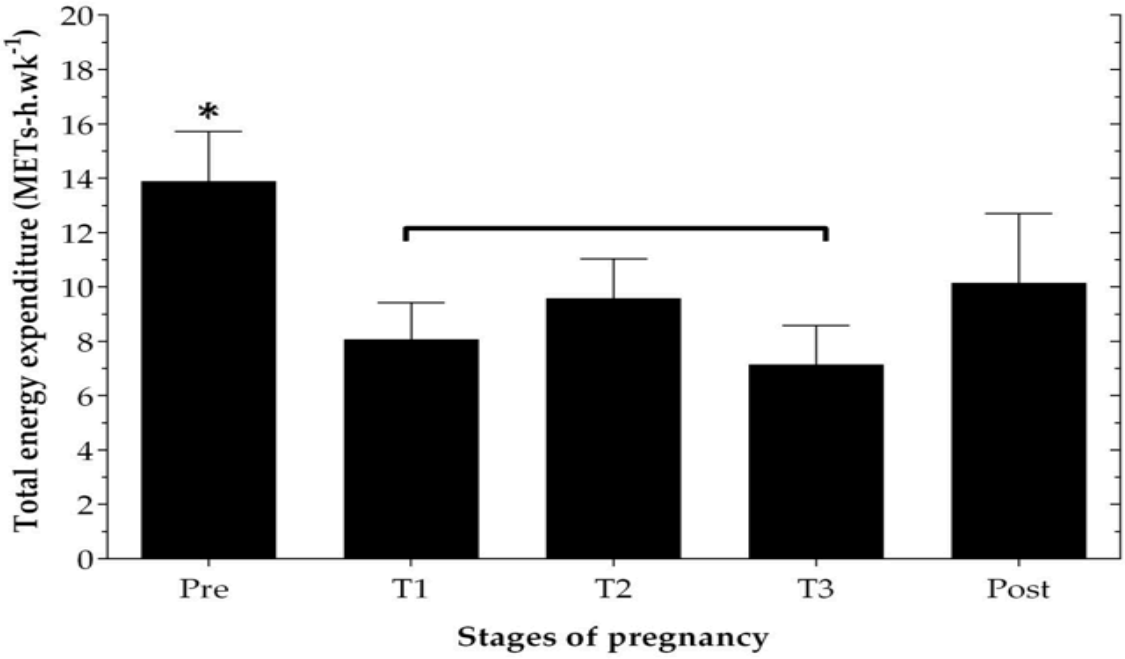

Figure 2 Mean energy expenditure of physical activity before, during & after pregnancy in the previous week

Notes: Data are presented as means with 95% confidence intervals. The number of participants at each time point varies: pre-pregnancy (n=200), first trimester (n=191), second trimester (n=156), third trimester (n=100), and postpartum (n=93). Data were collected using the Active Australia Survey (AAS). *Significant difference between pre-pregnancy and the first and third trimesters.

Women were asked to report information only on the duration, frequency, and type of physical activity lasting more than 10 minutes and performed in the week prior to, during, and after pregnancy. Data, including the mean (SD) and the 25th and 75th percentiles for women's self-reported responses, are presented in Table 3.

Table 3 Energy expenditure values in MET-h.wk-^{1} for physical activity across the five study stages for the Active Australia Survey (AAS)

Stages	Mean MET-h.w^{-1}	SD	25th Percentile	Median	75th Percentile
Total (MET-h.wk^{-1})					
Pre-pregnancy:					
Walking quickly	24.42	30.87	2.06	12.00	35.63
Moderate leisure activity	5.56	9.94	0.00	0.00	8.00
Strong leisure activity	15.25	25.41	0.00	0.00	24.00
Strong household/gardening	9.99	19.34	0.00	0.00	12.00
Trimester one:					
Walking quickly	21.35	33.27	0.00	6.75	27.00
Moderate leisure activity	2.56	6.13	0.00	0.00	2.00
Strong leisure activity	3.23	10.33	0.00	0.00	0.00
Strong household/gardening	5.55	11.86	0.00	0.00	6.00
Trimester two:					
Walking quickly	21.4	24.7	0.0	12.3	36.0
Moderate leisure activity	5.8	11.2	0.0	0.0	6.0
Strong leisure activity	2.2	5.8	0.0	0.0	0.0
Strong household/gardening	8.6	13.6	0.0	0.5	12.0
Trimester three:					
Walking quickly	13.69	18.89	0.00	3.75	23.63
Moderate leisure activity	4.43	8.38	0.00	0.00	7.50
Strong leisure activity	0.79	2.83	0.00	0.00	0.00
Strong household/gardening	9.26	17.33	0.00	0.00	12.00
Postpartum:					
Walking quickly	18.3	21.9	0.0	9.0	27.0
Moderate leisure activity	1.1	2.7	0.0	0.0	0.0
Strong leisure activity	2.2	5.6	0.0	0.0	0.0
Strong household/gardening	2.0	4.5	0.0	0.0	1.0

Notes: The number of participants in each time point is different at Pre-pregnancy; n=200, trimester one; n=191, trimester two; n=156, trimester three; n=100, postpartum; n=93.

Figure 3 shows the four main activities, as measured by the Active Australia Survey. The results indicate that brisk walking was the most common activity and contributed the most to energy expenditure across all five study stages, accounting for approximately 54% of total energy expenditure, with a mean of 20.7 ± 4.0 MET-h/week. It was most prevalent pre-pregnancy, representing 44% of activity, with a mean of 24.4 ± 30.9 MET-h/week. Brisk walking showed a significant difference ($p < 0.05$) from pre-pregnancy through postpartum compared to moderate leisure activity, vigorous leisure activity, and vigorous household or gardening activities. Figure 3 also shows a significant difference ($p < 0.05$) between vigorous household or gardening activities and both moderate and vigorous leisure activities in the first, second, and third trimesters. Vigorous household or gardening activities were the second largest contributor to energy expenditure, at approximately 22%, with a mean of 8.3 ± 1.6 MET-h/week across all time points. Vigorous leisure activity energy expenditure was lowest in the third trimester and made the smallest contribution to total energy expenditure, at only 3%.

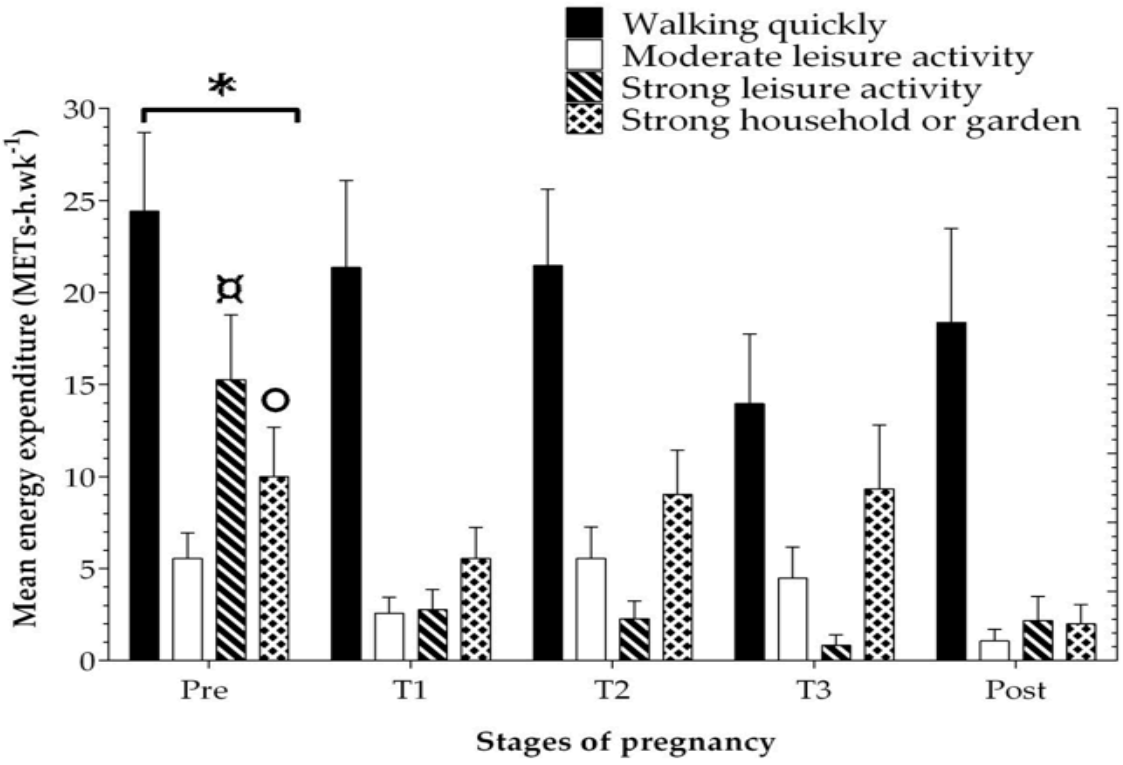

Figure 3 Mean energy expenditure of participation in different modes of physical activity before, during & after pregnancy in the previous week

Notes: Data are presented as means with 95% confidence intervals. The number of participants at each time point varied: pre-pregnancy (n=200), first trimester (n=191), second trimester (n=156), third trimester (n=100), and postpartum (n=93). Data were collected using the Active the Australia Survey (AAS). *Significant difference between brisk walking and moderate leisure activity, vigorous leisure activity,, and vigorous household or gardening activities from pre-pregnancy through the pregnancy stages. ¤ Significant difference associated with household or gardening activities and moderate and vigorous leisure activities in the first, second, and third trimesters, and with moderate leisure activity pre-pregnancy. ° Significant difference between vigorous leisure activity and both moderate leisure activity and vigorous household or gardening activities.

Respondents reported spending the most time brisk walking for recreation, exercise, or transportation. Figure 3 shows that brisk walking accounted for the largest mean energy expenditure from pre-pregnancy through postpartum. The proportion of participants reporting brisk walking was approximately 44% (24.4 ± 30.9 MET-h/week) pre-pregnancy. Values for the first and second trimesters were similar, at approximately 61% (21.4 ± 33.3 and 21.4 ± 24.7 MET-h/week, respectively), and then significantly decreased in the third trimester to 49% (13.7 ± 18.9 MET-h/week) before increasing to 55% (22.2 ± 22.0 MET-h/week) postpartum.

Strong Vigorous leisure activity, such as aerobics, running, swimming, and vigorous cycling (Figure 3), showed the highest mean total METs pre-pregnancy (15.3 ±25.4 MET-h.wk^{-1}). Women expended the least energy (0.8 ±2.8 MET-h.wk^{-1}) on strong leisure activity during the third trimester. In the first and second trimesters, strong leisure activity was also low and relatively constant (3.2 ±10.3, 2.2 ±5.8 MET-h.wk-^{1} respectively), accounting for approximately 7% and 9% of the total energy expenditure in each trimester. However, vigorous leisure activity energy expenditure changed markedly during the postpartum period to 17% (7.1 ±5.7 MET-h.wk^{-1}).

Strong household activities or gardening (Figure 3) showed relatively consistent levels throughout the stages of pregnancy. Strong household activities made the highest contribution to energy expenditure pre-pregnancy (10 ±19.3 MET-h.wk^{-1}). The study results indicated that women spent a reasonable amount of time on vigorous household or gardening activities. For example, women reported a constant contribution to energy expenditure in the first trimester (17%, 5.6 ±11.7 MET-h.wk-^{1}), second trimester (24%, 8.6 ±13.6 MET-h.wk^{-1}), third trimester (33%, 9.3 ±17.3 MET-h.wk^{-1}), and postpartum (19%, 7.7 ±20.7 MET-h.wk-^{1}).

Moderate leisure activities, such as social tennis, recreational swimming, and dancing (Figure 3), presented identical and slightly higher contributions to energy expenditure in prior pregnancies and the second trimester (5.6 ±10.8 MET-h.wk^{-1} for both). Generally, the lowest moderate leisure activity energy expenditure for all stages of pregnancy was observed postpartum at 9% with mean of 3.6 ±12.9 MET-h.wk^{-1} and in the first trimester at 8% with mean of 2.6 ±9.9 MET-h.wk^{-1} presented a small contribution to energy expenditure.

Meeting Australian Physical-activity Guidelines

Total mean physical activity energy expenditure (MET-h.wk^{-1}) during pregnancy, as assessed by the Active Australia Survey (AAS) across the five stages (pre-pregnancy, during pregnancy, and postpartum), was analyzed to determine if pregnant Australian women meet the minimum Australian physical activity guidelines. For this analysis, the study examined physical activity levels in units of 10 MET-hours/week (MET-h.wk^{-1}) to test whether the mean total energy expenditure of the entire sample differed significantly from the National Physical Activity Guidelines of Australia.

The degree to which participants met the physical activity norms, as determined by responses to the Active Australia Survey, was calculated for each stage: pre-pregnancy,

each trimester, and postpartum. The aim was to examine the level of physical activity participation before pregnancy, during each trimester, and postpartum. Figure 4 shows the proportion of weekly energy expenditure (MET-h.wk^{-1}), demonstrating that the proportion of pregnant women who were sufficiently active and met the National Physical Activity Guidelines decreased from 51% pre-pregnancy to approximately 31% and 43% in the first and second trimesters respectively, and declined in the third trimester and postpartum to 27% and 33% respectively. Therefore, Australian pregnant women did not meet the Australian physical-activity guidelines.

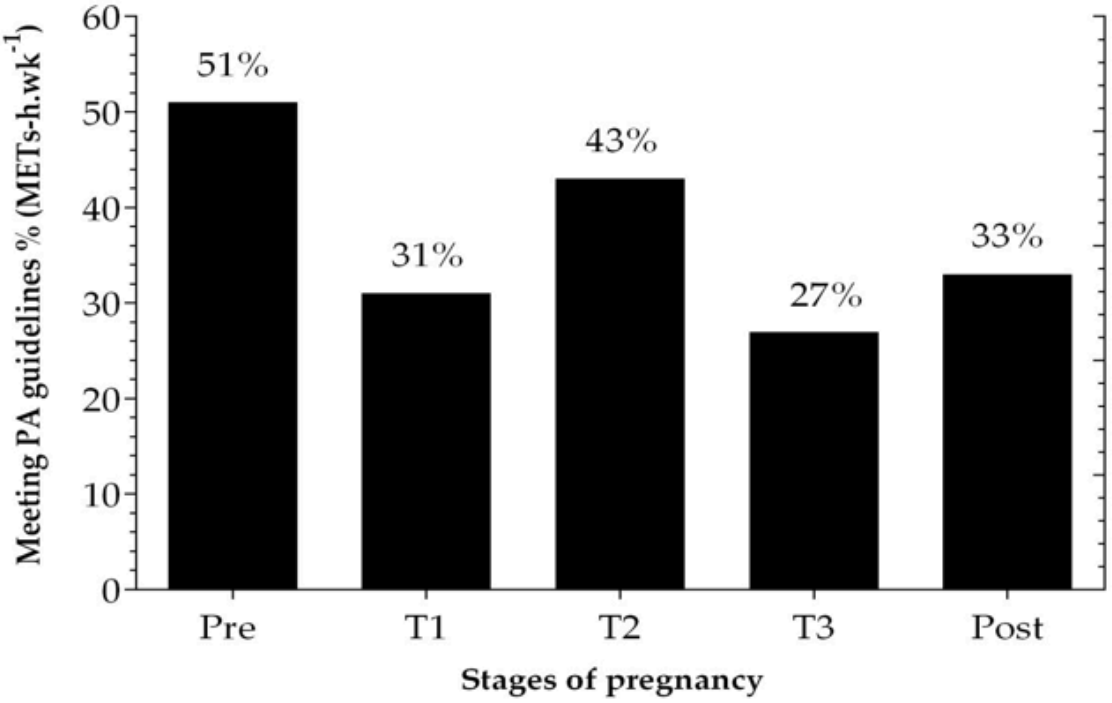

Figure 4 The proportion of pregnant women that met the Australian physical activity recommendations before, during & after pregnancy (AAS)

Notes: Data are presented as means with 95% confidence intervals. The number of participants at each time point varied: pre-pregnancy (n = 200), first trimester (n = 191), second trimester (n = 156), third trimester (n = 100), and postpartum (n = 93). Data were collected using the Active Australia Survey (AAS).

Changes in physical activity levels

This study examined changes in physical activity levels by following 45 participants from pre-pregnancy through the postpartum period. The aim was to understand temporal changes in physical activity participation during each trimester of pregnancy.

Table 4 shows participants' weight gained before, during, and after pregnancy (n = 45). Pre-pregnancy body mass ranged from 60.8 ± 11.5 kg to 63.1 ± 11.4 kg. Mean body mass increased during pregnancy: 63.8 ± 11.2 kg in the first trimester, 68.2 ± 11.6 kg in the second trimester, and 73.9 ± 11.3 kg in the third trimester. Postnatal average body mass declined to 65.9 ± 11.2 kg. Results showed increases in body mass index (BMI) and body mass during the third trimester compared to pre-pregnancy, the first and second trimesters, and postpartum.

Table 4 Gestational weight gain (kg)

Stages	Body mass (kg)	Change (g)
Pre-pregnancy	63.1 ±11.4	-
Trimester one	63.8 ±11.2	3049
Trimester two	68.2 ±11.6	4418
Trimester three	74 ±11.3	5696
Postpartum	65.9 ±11.2	-6751

Notes: Participants (n=45)

Based on the recommendations for weight gain during pregnancy by Rasmussen and Yatkine (2009), participants were grouped as normal weight; their approximate weight gain during pregnancy was 13.2 kg, which falls within the recommended range.

Women reported engaging in exercise in early/mid-pregnancy, but less so in late pregnancy. Approximately half of the women exercised regularly at some point during pregnancy, meaning that about half of those exercising in early/mid-pregnancy had stopped exercising by late pregnancy, while another group of women had begun

exercising. A one-way repeated-measures ANOVA was conducted to test whether the level of physical activity remained consistent across trimesters, and therefore to compare physical activity energy expenditure for 45 pregnant women in each trimester. In this study, results from the Active Australia Survey indicated a *p*-value of less than 0.05. Therefore, there was a statistically significant change in physical activity across the different time periods of the study, which *contradicted* the study's expectation that physical activity levels would remain the same during trimesters.

Discussion

In this investigation, 66.3% of pregnant women did not meet the Australian physical activity guidelines. Participants' mean weekly physical activity energy expenditure was less than the recommended (10 MET-h.wk-^{1}). The finding that only 33.7% of pregnant women achieved the recommended 150 minutes of physical activity per week is nearly identical to that reported by the only existing study comparing physical activity during pregnancy to Australian physical activity norms (Wilkinson et al., 2009), which found that 32.8% of pregnant women participated in the minimum recommended amount of physical activity. However, Wilkinson et al. (2009) sampled women at a mean gestational age of 19.4 weeks. Gestational stage is an important consideration, as physical activity levels have been reported to decline by 40% by the third trimester (Duncombe et al., 2007). This study focused only on leisure-time physical activity and did not assess time spent in occupational, transportation, or household physical activity during pregnancy, which does not reflect the full amount of activity performed. These areas of physical activity are important and are known to be maintained or even increased during pregnancy (Evenson et al., 2004a). Furthermore, the current findings observed a slightly higher proportion of pregnant women meeting the recommended physical activity levels (33.7%) compared to Wilkinson et al. (2009) (32.8%).

Larger studies have reported significantly lower compliance with physical activity guidelines, with approximately 12% of mothers observed as meeting the minimum recommendations at 20 and 32 weeks of gestation (Borodulin et al., 2008; DiNallo et al., 2008; Evenson et al., 2004b). For example, Evenson et al. (2014) evaluated the prevalence of recommended leisure activity among pregnant women and found that it was lower (15.8%) than among non-pregnant women (26.1%). Participation in any recommended leisure activity was low, while the prevalence of inactivity was higher during pregnancy than non-pregnancy. The lower proportion of women meeting the recommended physical activity levels in these studies (15.8%) compared to the current investigation (33.7%) may be due to the fact that previous studies did not include all types of activity, such as household, caregiving, and work-related activities.

This study indicated that the proportion of pregnant women meeting recommended physical activity guidelines is low. Consistent with these findings, approximately 50% of adults in developed countries do not meet physical activity recommendations, thereby missing the health benefits of exercise (Armstrong et al., 2000; Bauman et al., 2009). Such recommendations should be considered in every exercise plan and further investigated (Artal et al., 2003). Additionally, the reduction in exercise levels may be due to inadequate knowledge about recommended physical activity among both healthcare personnel advising pregnant women and pregnant women themselves. Given the limited data on adherence to Australian physical activity guidelines, particularly data obtained within Australia, further investigation is required. Future research should utilize a larger, nationally representative sample to obtain more accurate estimates of the proportion of Australian women meeting the recommended physical activity guidelines.

The study findings showed that the prevalence of physical activity participation varied significantly across the different stages: pre-pregnancy (49%), increasing significantly in

the first trimester (69%), then to 57% in the second trimester, 73% in the third trimester, and 77% postpartum. However, the majority of women did not reach the recommended level of activity. There are no existing data on women who did not meet recommended physical activity norms during each trimester with which to compare the current study's findings. The only previous study investigating recommended physical activity levels among pregnant women (Wilkinson et al., 2009) collected data at a single time point, approximately 19 weeks of gestation.

Results from the Active Australia Survey showed that brisk walking made the largest contribution to energy expenditure before, during, and after pregnancy. Women spent the most time walking briskly (54%), likely because walking is incorporated into multiple activities, such as recreation, exercise, and transportation. Similarly, a previous study found that brisk walking and bicycling were the two most commonly preferred activities both pre- and during pregnancy (47.7% and 24.9%, respectively) (Owe et al., 2009). Increased attention has been noted as one of the health benefits of walking (Andersen, 2007). Compared with other physical activities, such as recreational and vigorous leisure activities, which were reported by 28% of participants pre-pregnancy, 6% during pregnancy, and 17% postpartum, brisk walking was a top preferred activity, showing significant frequency before (44%), during (57%), and after pregnancy (55%), likely because of its consistently low intensity. Consistent with the current findings, several previous physical activity studies have found that walking is a common and appropriate activity for pregnant women at all stages (Alderman et al., 1998; Haakstad et al., 2007).

Consistent with the current findings, individuals can achieve physical activity recommendations by briskly walking for 30 minutes twice a week and jogging for 20 minutes on two additional days (Armstrong et al., 2000; Haskell et al., 2007; McParlin et al., 2010). Studies of daily physical activity have shown that walking at a reasonable

pace (5 km/h) expends sufficient energy to meet physical activity recommendations and may improve health in sedentary women (Ainsworth et al., 2000; McParlin et al., 2010; Ready et al., 1996). Further supporting the current results, walking has been observed to be a sustainable and accessible physical activity that offers significant health benefits. For example, walking is associated with improved glycemic control in individuals with diabetes (Trenell et al., 2008). Pram walking in intervention groups has resulted in significant improvements in mothers' fitness levels (VO2 max, $p < 0.01$) compared with a control (social support) group (Armstrong & Helen, 2004). Walking is therefore a preferred exercise for women and an appropriate one that provides significant benefits (Evenson et al., 2004a; Mottola & Campbell, 2003; Ning et al., 2003; Owe et al., 2009; Petersen et al., 2005). In agreement with previous studies, participants in the current study reported a high total proportion of time spent walking briskly (54%) compared to moderate and vigorous leisure activity (12%, respectively) and vigorous household activity (22%). Moderate and vigorous leisure activity and vigorous household and gardening activities were generally very low. Brisk walking can be considered a natural activity performed by both males and females without requiring exceptional physical ability.

Similarly, compared with pre-pregnancy levels, all types of activity declined throughout pregnancy, with the exception of walking. Among women participating in a structured brisk walking program before pregnancy, 29% were participating in no exercise by late pregnancy. However, of the group involved in other activities pre-pregnancy, 30% had switched to walking in the third trimester (Mottola & Campbell, 2003). Results from the current investigation showed that brisk walking was the main physical activity choice for most pregnant women. Likewise, another study found that walking was a commonly mentioned example of good exercise during pregnancy and was reported as one of the most frequent activities before and during

pregnancy (Owe et al., 2009). Despite the importance of brisk walking, no study has examined the extent to which walking among pregnant women contributes to meeting physical activity guidelines. Based on these findings, encouraging walking may be beneficial for pregnant women in meeting nationally recommended physical activity levels.

Conclusions

This study indicated that the proportion of pregnant women meeting recommended guidelines is significantly low. Consistent with existing findings, approximately 50% of adults do not meet physical activity recommendations, thus missing the health benefits of exercise (Armstrong et al., 2000; Bauman et al., 2009). The high proportion of women not meeting exercise guidelines is associated with the reported reduction in maternal exercise levels. This decline, as well as the recommendations themselves, should be considered in every exercise plan and further investigated (Artal et al., 2003). Additionally, the reduction in exercise levels may be due to insufficient information about recommended physical activity among both healthcare providers and pregnant women. Failure to achieve recommended physical activity levels may suggest an increase in sedentary maternal lifestyles, potentially leading to illness, overweight, and overall poor health.

Furthermore, given the limited data used to examine adherence to Australian physical activity guidelines, further investigation is required. Future research should use a larger, nationally representative sample to obtain more accurate estimates of the proportion of Australian pregnant women meeting recommended physical activity guidelines. Currently, there is limited data on women who do not meet recommended physical activity norms during each trimester. Further research is warranted to identify activity patterns associated with meeting recommended physical activity levels during pregnancy. This investigation highlights the need for healthcare providers to promote

physical activity during pregnancy. The findings of low exercise participation suggest encouraging pregnant women to engage in a variety of maternal exercises, especially activities of daily living.

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