


Factors related to weight gain in pregnancy in Deli Serdang District, North Sumatera, Indonesia

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Received: 4 Jan 2025

Published: 19 May 2025

Abstract

Background: Appropriate weight gain during pregnancy is crucial for maternal and fetal health. This study aimed to identify factors associated with achieving recommended weight gain among pregnant women in Deli Serdang Regency, North Sumatra, Indonesia.

Methods: A cross-sectional study was conducted in 2023 involving 248 pregnant women in the third trimester at five health centers in Deli Serdang Regency, North Sumatra. Data were collected through structured interviews and questionnaires covering demographic factors, knowledge, behavior, and nutritional intake. Weight gain during pregnancy was recommended based on IOM recommendations. Analysis was performed using the Chi-square test and multinomial logistic regression with 95% confidence intervals using SPSS version 26.

Results: The study looked at how gestational weight gain was affected by various factors. Significant factors linked to recommended weight gain included energy, protein, fat, and carbohydrate intake, physical activity, knowledge, perception, and family support (all with p-values less than 0.05). However, maternal age, education, job, income, number of previous births, and smoking habits did not significantly affect weight gain. Pregnant women who consumed enough energy (AOR = 0.188, $P = 0.006$), low-fat (AOR = 0.204, $P = 0.031$), and enough carbohydrates (AOR = 0.065, $P = 0.045$) were less likely to gain too little or too much weight. Physical activity was very important: light (AOR = 0.133, $P < 0.001$) and moderate (AOR = 0.250, $P = 0.001$) exercise lowered the risk of gaining less weight than recommended. Low physical activity increased the risk of gaining too much weight (AOR = 3.458, $P = 0.039$), and was the strongest factor affecting weight gain. Additionally, poor pregnancy planning increased the risk of gaining too much weight (AOR = 2.328, $p = 0.048$), and low family support raised the risk of gaining too little weight (AOR = 2.571, $P = 0.023$).

Conclusion: Physical activity is the most influential factor in achieving recommended weight gain; the more active the pregnant woman is, the greater the chance of achieving the appropriate weight.

Keywords: Pregnancy weight gain, Nutrition Intake, Family support, Knowledge, Physical activity

Conflicts of Interest: None declared

Funding: None

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Cite this article as: Mala Sari N, Indrawaty Lipoeto N, Bachtiar A, Ariadi, Machmud R, Defrin, Mudjiran, Sulastr D. Factors related to weight gain in pregnancy in Deli Serdang District, North Sumatera, Indonesia. *Med J Islam Repub Iran*. 2025 (19 May);39:69. <https://doi.org/10.47176/mjiri.39.69>

Introduction

Pregnancy is an important period for the mother and fetus, where the body undergoes physiological changes that require special care to maintain health. One crucial aspect is weight gain, which must be in accordance with recommendations to support healthy fetal growth and reduce the risk of complications. Weight gain that is not in accordance

with recommendations is a global problem, with a prevalence reaching 60% - 80% in various countries (1) A study conducted across 16 countries from five geographic regions reported a prevalence of 66%, consisting of 29% of women gaining below and 37% above the recommended weight (2) In Bangladesh, the prevalence was as high as 74.9% (3) while in Spain, 67.3% of pregnant women did not meet the

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↑What is "already known" in this topic:

In Indonesia, pregnant women still do not pay enough attention to the recommended weight gain. Pregnant women only know about weight gain without paying attention to their BMI before pregnancy.

→What this article adds:

Physical activity and food intake during pregnancy greatly affect the increase in recommended weight gain during pregnancy.

IOM recommendations (4). In Indonesia, although data on maternal weight gain remain limited, local studies also show a high rate of inappropriate weight gain, such as 63.7% in Bandung (5) and 64% at Pahandut Health Center, Palangka Raya City (6). Inappropriate weight gain can increase the risk of complications for the mother and fetus, such as hypertension, gestational diabetes, preeclampsia, premature birth, and low birth weight. (7) Therefore, it is important to identify factors that influence weight gain during pregnancy.

Methods

Design Study

This study is analytical observational research with a cross-sectional design, conducted over a period of eight months, from June to January 2024. The research was carried out at five primary health centers (Puskemas) in Deli Serdang District, North Sumatra Province, Indonesia, namely Delitua, Patumbak, Namo Rambe, Biru-Biru, and Talun Kenas. Data collection was conducted through structured interviews and questionnaires filled out by respondents with the assistance of trained enumerators—seventh-semester undergraduate students from the Nutrition Study Program who had undergone a one-week training.

Population and Participants

The population in this study consisted of all third-trimester pregnant women who attended antenatal care (ANC) visits at selected primary health centers (Puskemas) in the five chosen locations during the study period. A random sampling method was used to select the five Puskemas in Deli Serdang District. The sample was selected using purposive sampling, based on specific inclusion criteria relevant to the research objectives. The inclusion criteria were: (1) third-trimester pregnancy, (2) maternal age between 22 and 45 years, (3) ability to read and write, and (4) willingness to participate in the study by signing an informed consent form. The exclusion criteria included pregnant women with multiple pregnancies, chronic illnesses (such as diabetes or hypertension), and those who could not recall their pre-pregnancy weight.

How to select participants

Pregnant women who attended antenatal care at five primary health centers (Puskemas) during the study period were selected as participants.

Variables

The dependent variable in this study is gestational weight gain (GWG), while the independent variables include demographic factors such as age, education, employment, income, and parity. Additionally, determinant factors are considered, including smoking habits, maternal knowledge, antenatal care (ANC) visits, pregnancy planning, maternal perception of weight gain, family support, physical activity, and dietary intake encompassing energy, protein, fat, and carbohydrates.

Data sources and measurement methods

Gestational weight gain is calculated as the difference between third-trimester weight (measured directly using a scale) and pre-pregnancy weight (reported by the mother and verified through the maternal and child health (MCH) book and medical records). The results were categorized as below, within, or above the recommended guidelines based on the Institute of Medicine (IOM) standards.

Independent variables in this study include demographic factors and determinant factors. Demographic factors consist of age, which is asked directly and categorized into three groups: less than 25 years, 25 to 35 years, and more than 35 years; parity categorized as primipara and multipara; education level categorized as low (junior and senior high school) and high (college or university); employment status divided into employed and unemployed; and income compared to the minimum wage of Deli Serdang (IDR 3,188,592), categorized as below minimum wage and equal to or above minimum wage.

Determinant factors include smoking habit, assessed through a questionnaire and categorized as smoker and non-smoker; maternal knowledge measured using 16 multiple-choice questions with validity ranging from 0.396 to 0.798 and reliability (Cronbach's Alpha) of 0.857, categorized as good or poor knowledge; antenatal care visits, data obtained from maternal health books and interviews, categorized as less than 6 visits and 6 or more visits; pregnancy planning measured using six Likert-scale statements (scale 1–5) with validity ranging from 0.755 to 0.907 and reliability of 0.912, categorized as good and poor planning; maternal perception of weight gain measured with six Likert-scale statements (scale 1–5) with validity from 0.718 to 0.914 and reliability of 0.920, categorized as positive and negative perception; family support measured using six Likert-scale statements (scale 1–5) with validity ranging from 0.795 to 0.855 and reliability of 0.907, categorized as good and poor support; physical activity measured with the Indonesian version of the Global Physical Activity Questionnaire (GPAQ), covering work, transportation, recreation, and sitting time, with validity above 0.296 and reliability above 0.8, and results converted to MET-minutes per week categorized as light, moderate, and heavy activity levels; and nutrient intake including energy, protein, fat, and carbohydrates measured using the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) through interviews conducted by enumerators, with validity ranging from 0.42 to 0.89 and reliability ranging from 0.6 to 0.9. The nutrient intake data are converted to grams per day using the Indonesian Food Composition Table (DKBM) and analyzed with NutriSurvey 2007 software, then compared with the Recommended Dietary Allowance (RDA) according to the pregnancy trimester based on the Ministry of Health Regulation No. 28/2019, and categorized into less, adequate, and excess intake.

Efforts to reduce bias

To minimize potential bias, this study implemented several measures, including the use of validated instruments (the Indonesian versions of GPAQ and SQ-FFQ). Additionally, the validity and reliability of the instruments were

tested through a pilot study involving 30 pregnant women at Pancur Batu Community Health Center, who were not included in the main sample. Data collection was conducted following standardized timing and procedures. Training was provided to researchers and enumerators prior to data collection to ensure procedural consistency. Direct supervision by the principal investigator, standardization of all data collection processes, and strict application of inclusion and exclusion criteria were also enforced to ensure sample homogeneity.

Sample size

The sample size consisted of 248 respondents. It was calculated using the population proportion estimation formula, based on an assumed proportion from previous studies, with a 95% confidence level and a 5% margin of error.

Handling lost data

Missing data were handled by excluding respondents who did not complete the questionnaire fully or had missing key information, such as pre-pregnancy weight data. Exclusion was performed prior to statistical analysis to minimize potential bias and maintain the validity of the study results.

Statistical Analysis

The univariate analysis was conducted using descriptive statistics, where data for categorical variables such as education, income, occupation, and smoking habit are presented in frequency distribution tables. For numerical variables including age, parity, BMI, energy intake, protein intake, carbohydrate intake, fat intake, physical activity, antenatal care (ANC) visits, pregnancy planning, maternal knowledge, perception of weight gain, family support, and maternal weight gain during pregnancy, the data are displayed as frequency percentages. Bivariate analysis using the Chi-Square test was then performed to examine the relationship between independent variables and weight gain in pregnant women, with a p-value less than 0.05 considered statistically significant. Furthermore, variables with a p-value less than 0.25 in the bivariate analysis were included in the multivariate analysis. Multivariate analysis using multinomial logistic regression was conducted to identify factors influencing the categories of weight gain—

below, within, and above recommended guidelines. Data analysis was performed using IBM SPSS version 26.

Role of Students in Data Collection:

Data collection was conducted by seventh-semester students from the Bachelor of Nutrition Study Program. They had received prior training on interview procedures, questionnaire administration, and anthropometric measurements. The students were directly supervised and guided by the principal investigator and academic advisors throughout the data collection process. All interviewers adhered to standard operating procedures (SOP) to ensure consistency and data quality.

Results

1. Socio-demographic characteristics of maternal weight gain in pregnancy

Based on Table 1, the majority of respondents in this study were aged under 25 or over 35 years (54%), had a low level of education (junior to senior high school) at 67.7%, and more than half (57.7%) had an income below the Regional Minimum Wage (UMK). Most of the respondents were unemployed (67.6%) and were multiparous mothers (76.6%).

2. Determinant Factors of Weight Gain in Pregnant Women

Based on Table 2, the majority of respondents did not smoke (93.5%), had low energy intake (40.3%), excessive protein intake (34.7%), adequate fat intake (38.7%), and low carbohydrate intake (77%). Most of them engaged in light physical activity (40.3%), had fewer than six ANC visits (57.3%), and had poor pregnancy planning (56%). In addition, most respondents had poor knowledge (50.8%), negative perceptions of weight gain during pregnancy (54.8%), and received inadequate family support (57.7%). Most of them experienced weight gain within the recommended range (50%).

3. Determinant Factors Related to Weight Gain in Pregnant Women

Based on the results of bivariate analysis in Table 3, examining the relationship between maternal characteristics and gestational weight gain according to the Institute of

Table 1. Socio-Demographic Characteristics

NO	Variabel	F	(%)
1.	Age		
	< 25 or > 35	134	54
	25–35	114	46
2.	Education		
	Low (Elementary School-High School)	168	67,7
	High (D3–PT)	80	32,3
3.	Income		
	< Below UMK (Wage < Rp. 3,188,592.42)	143	57,7
	≥ By or above UMK (Wage ≥ Rp. 3,188,592.42)	105	42,3
4.	Work		
	No	168	67,6
	Yes	80	32,3
5.	Parity		
	Multipara	190	76,6
	Primipara	58	23,4

Table 2. Determinant Factors of Increased Weight of Pregnant Women in Deli Serdang Regency

NO	Variabel	F	(%)
1	Smoking Habit		
	Yes	16	6,50
	No	232	93,5
2	Energy Intake		
	Less	100	40,3
	Enough	52	21
	More	96	38,7
3	Protein Intake		
	Less	81	32,7
	Enough	81	32,7
	More	86	34,7
4	Fat Intake		
	Less	78	31,5
	Enough	96	38,7
	More	74	29,8
5	Carbohydrate Intake		
	Less	191	77
	Enough	50	20,2
	More	7	2,8
6	Physical activity		
	Light	100	40,3
	Medium	82	33,1
	Heavy	66	26,6
7	ANC Visit		
	<6 times	142	57,3
	≥6 times	106	42,7
8	Pregnancy Planning		
	Not Good	139	56
	Good	109	44
9	Knowledge		
	Not Good	126	50,8
	Good	122	49,2
10	Perception		
	Negatives	136	54,8
	Positif	112	45,2
11	Family Support		
	Not good	143	57,7
	Good	105	42,3
12	Gestational Weight Gain		
	Inadequate	67	27
	Adequate	124	50
	Excessive	57	23
	Total	248	100

Table 3. Socio-Demographic Relationship With Maternal Weight Gain During Pregnancy

No	Variable	Weight Gain as per IOM recommendations			P value
		Inadequate f (%)	Adequate f (%)	Excessive f (%)	
1	Age				
	<25 or >35	37(55.2)	65(52.4)	32(56.1)	0.874
	25 – 35	30(44.8)	59(47.6)	25(43.9)	
	Education				
	Low (Elementary School-High School)	44 (65.7)	86(69.4)	38(66.7)	0.857
	High (D3-PT)	23(34.3)	38(30.6)	19(33.3)	
	Work				
	No	44 (65.7)	84(67.7)	40(70.2)	0.867
	Yes	23(34.3)	40(32.3)	17(29.8)	
	Income				
	< Below UMK (Wage < Rp. 3,188,592.42)	36(53.7)	76(61.3)	31(54.4)	0.511
	≥ By or above UMK (Wage ≥ Rp. 3,188,592.42)	31(46.3)	48(38.7)	26(45.6)	
	Parity				
	Multipara	54(80.6)	96(77.4)	40(70.2)	0.376
	Primipara	13(19.4)	28(22.6)	17(29.8)	

Medicine (IOM) guidelines, it was found that the variables age ($P = 0.874$), education level ($P = 0.857$), employment status ($P = 0.867$), income level ($P = 0.511$), and parity ($P = 0.376$) did not show a significant relationship with gestational weight gain according to recommendations.

4. Relationship between determinant factors and weight gain in pregnant women

Based on Table 4, several variables exhibit statistically significant associations with gestational weight gain during pregnancy. Excessive intake of energy, protein, and carbohydrates is correlated with excessive weight gain ($P = 0.000$ for all). Additionally, light physical activity ($P = 0.000$), inadequate knowledge ($P = 0.000$), negative perceptions regarding pregnancy and nutrition ($P = 0.008$), and insufficient family support ($P = 0.004$) are associated with inappropriate weight gain. Conversely, variables such as smoking habits ($P = 0.561$), frequency of antenatal care visits ($P = 0.147$), and pregnancy planning ($P = 0.052$) do not show significant associations with gestational weight gain. These findings underscore the importance of addressing modifiable factors like dietary intake, physical activity, knowledge, perception, and family support to achieve appropriate weight gain during pregnancy.

5. Multinomial Regression Analysis of Pregnant Women's Weight Gain

The analysis results in Table 5 show that, compared to pregnant women who experienced adequate

weight gain, those with inadequate weight gain were significantly influenced by several factors. Low fat intake (Fat Intake=1) significantly increased the risk of inadequate weight gain by 3.77 times ($P = 0.034$; 95% CI: 1.103–12.907), as did low carbohydrate intake (Carbohydrate Intake = 1), which increased the risk by 6.94 times ($P = 0.000$; 95% CI: 2.030–2.369). High physical activity (Physical Activity=1) significantly reduced the risk (AOR=0.107; $P < 0.001$), as did moderate physical activity (Physical Activity = 2) (AOR = 0.178; $P < 0.001$). Low family support (Family Support=1) was also found to significantly increase the risk of inadequate weight gain by 3.6 times ($p=0.005$; 95% CI: 1.488–8.732). Other variables, such as antenatal care visits, pregnancy planning, knowledge, and perception, showed no statistically significant association, with p -values greater than 0.05.

Pregnant women who experienced excessive weight gain, compared to those who gained weight within the recommended range, were significantly influenced by several factors. Low fat intake (Fat Intake=1) was found to reduce the risk of excessive

Table 4. Relationship between determinant factors and weight gain in pregnant women

No	Variable	Weight Gain as per IOM recommendations			P Value
		Inadequate f (%)	Adequate f (%)	Excessive f (%)	
1.	Smoking Habit				
	yes	5(7.5)	6(4.8)	5(8.8)	0.561
	No	62(92.5)	118(95.2)	52(91.2)	
2.	Energy Intake				
	Less	43(64.2)	50(40.3)	7(12.3)	<0.001
	Enough	11(16.4)	35(28.2)	6(10.5)	
	More	13(19.4)	39(31.5)	44(77.2)	
3.	Protein Intake				
	Less	34(50.7)	41(33.1)	6(10.5)	<0.001
	Enough	26(38.8)	45(36.3)	10(17.6)	
	More	7(10.4)	38(30.6)	41(71.9)	
4.	Fat Intake				
	Less	35(52.3)	39(31.5)	4(7.0)	<0.001
	Enough	22(32.8)	54(43.5)	20(35.1)	
	More	10(14.9)	31(25)	33(57.9)	
5.	Carbohydrate intake				
	Less	60(89.6)	89(71.8)	24(42.1)	<0.001
	Enough	7(10.4)	34(27.4)	29(50.9)	
	More	0(0)	1(0.8)	4(7)	
6.	Physical activity				
	Light	11(16.4)	47(37.9)	42(73.7)	<0.001
	Medium	20(29.9)	53(42.7)	9(15.8)	
	Heavy	36(53.7)	24(19.4)	6(10.5)	
7.	ANC Visit				
	<6 times	37(55.2)	66(53.2)	39(68.4)	0.147
	≥6 times	30(44.8)	58(46.8)	18(31.6)	
8.	Pregnancy Planning				
	Not Good	43(64.2)	60(48.4)	36(63.2)	0.052
	Good	24(35.8)	64(51.6)	21(36.8)	
9.	Knowledge				
	Not Good	44(65.7)	65(52.4)	17(29.8)	<0.001
	Good	23(34.3)	59(47.6)	40(70.2)	
10.	Perception				
	Negative	47(70.1)	58(46.8)	31(54.4)	0.008
	Positive	20(29.9)	66(53.2)	26(45.6)	
11	FamilySupport				
	Not Good	50(74.6)	62(50)	31(54.4)	0.004
	Good	17(25.4)	62(50)	26(45.6)	

Table 5. Multinomial Regression Analysis of Pregnant Women's Weight Gain

Weight gain in pregnant women										
	Inadequate vs adequate					Excessive vs adequate				
	B	Std. Error	P Value	Exp (B)	95% CI	B	Std. Error	P Value	Exp (B)	95% CI
[Energy Intake=1]	0.183	0.609	0.764	1.201	0.364-3.959	-1.430	0.816	0.080	0.239	0.048-1.185
[Energy Intake=2]	-0.160	0.627	0.799	0.852	0.249-2.915	-3.266	0.868	0.000	0.038	0.007-0.209
[Energy Intake=3]	Ref	.	.	.	.	0	.	.	.	.
[Protein Intake=1]	0.559	0.691	0.418	1.750	0.452-6.777	-0.743	0.836	0.374	0.476	0.092-2.446
[Protein Intake=2]	1.064	0.625	0.089	2.898	0.852-9.859	-1.033	0.653	0.114	0.356	0.099-1.280
[Protein Intake=3]	Ref	.	.	.	.	0	.	.	.	.
[Fat Intake=1]	1.328	0.627	0.034	3.774	1.103-12.907	-2.070	0.860	0.016	0.126	0.023-0.681
[Fat Intake=2]	0.047	0.592	0.937	1.048	0.328-3.345	-0.737	0.565	0.192	0.479	0.158-1.449
[Fat Intake=3]	Ref	.	.	.	.	0	.	.	.	.
[Carbohydrate Intake=1]	15.752	0.627	0.000	6.937	2.030-2.369	-2.434	1.763	0.167	0.088	0.003-2.776
[Carbohydrate Intake=2]	15.113	0.000	0.000	3.658	3.568 – 3.654	-2.639	1.806	0.144	0.071	0.002-2.463
[Carbohydrate Intake=3]	Ref	.	.	.	.	0	.	.	.	.
[Physical Activity=1]	-2.237	0.537	0.000	0.107	0.037-0.306	1.353	0.741	0.068	3.868	0.906-16.516
[Physical Activity=2]	-1.727	0.470	0.000	0.178	0.071-0.447	-0.295	0.816	0.718	0.745	0.150-3.868
[Physical Activity=3]	Ref	.	.	.	.	0	.	.	.	.
[Antenatal care visits=1]	0.095	0.393	0.809	1.100	0.509-2.374	0.950	0.548	0.083	2.586	0.883-7.571
[Antenatal care visits=2]	Ref	.	.	.	.	0	.	.	.	.
[Pregnancy Planning=1]	0.470	0.411	0.253	1.601	0.715-3.583	1.721	0.567	0.002	5.588	1.840-16.969
[Pregnancy Planning=2]	Ref	.	.	.	.	0	.	.	.	.
[Knowledge=1]	0.689	0.414	0.096	1.992	0.885-4.481	-1.102	0.545	0.043	0.332	0.114-0.966
[Knowledge=2]	Ref	.	.	.	.	0	.	.	.	.
[Perception=1]	0.325	0.415	0.434	1.384	0.613-3.122	0.839	0.519	0.106	2.313	0.837-6.394
[Perception=2]	Ref	.	.	.	.	0	.	.	.	.
[Family Support=1]	1.282	0.452	0.005	3.604	1.488-8.732	-0.661	0.517	0.201	0.516	0.187-1.423
[Family Support=2]	Ref	.	.	.	.	0	.	.	.	.

weight gain by 0.126 times ($P=0.016$; 95% CI: 0.023–0.681), indicating a protective effect. In contrast, low family support (Family Support=1) significantly increased the risk of excessive weight gain by 5.59 times ($p=0.002$; 95% CI: 1.840–16.969). High levels of physical activity (Physical Activity=1) also significantly decreased the risk of excessive weight gain (AOR=0.332; $P=0.043$; 95% CI: 0.114–0.966). Other variables, such as energy, protein, and carbohydrate intake, antenatal care visits, pregnancy planning, knowledge, and perception, did not show statistically significant associations ($P>0.05$).

Discussion

During pregnancy, the mother's body undergoes physiological changes such as increased blood volume and fat storage. Protein intake, pre-pregnancy BMI, and physical activity directly influence these processes. Maternal age also affects metabolic needs and the body's physiological adaptations. These factors are interrelated in supporting appropriate weight gain during pregnancy. The results of the study showed that there was no relationship between age, parity, education, and occupation with weight gain in pregnant women. This study is in line with research conducted by (8). The older the pregnant

woman, the less likely she is to experience weight gain according to recommendations. In older pregnant women, the body's metabolism tends to slow down so that weight management becomes more difficult. This study is not in line with research (9), which shows that women aged 35 years and over are more likely to experience weight loss or weight gain below recommendations. A more specific approach based on age and nutritional status before pregnancy is needed to achieve healthy and recommended weight gain (10).

Primigravida and multigravida mothers generally have similar access to information and education, so the number of previous children does not directly influence weight gain patterns. This result is in line with research (11) which shows there is no significant relationship between parity and weight gain during pregnancy, but currently this trend is consistent with evidence that pregnant women gain more weight at the first parity and are more careful about weight gain at the second parity and beyond (12, 13).

Maternal education level was not significantly associated with weight gain during pregnancy. Other factors, such as family support and access to health services, played a greater role. Research at the Tlogosari Wetan Health Center supports this finding

(14) and is not in line with research conducted by (15, 16) that low education will affect pregnant women's knowledge about recommendations for increasing pregnancy weight according to research (17) that 77% of pregnant women who do not receive formal education experience an increase in pregnancy weight below recommendations, as is the case with research conducted by (18) that pregnant women with low education are at greater risk of experiencing weight gain above IOM recommendations (1.76 (95% confidence interval 1.28-2.43) almost half of women with primary or secondary education (48%) experience excessive weight gain.

The results of the study showed that maternal employment status did not have a significant relationship with weight gain during pregnancy. This may be due to the fact that both working and non-working mothers have almost equal access to health information and antenatal services, as well as family support that can help in meeting nutritional needs. In addition, eating patterns and physical activity are more determined by individual habits than employment status itself. This finding is supported by research conducted by (8)

Research shows that family income has no significant relationship with maternal weight gain during pregnancy. This may be due to other factors such as pre-pregnancy nutritional status, nutrient intake, physical activity, and social support that play a greater role in determining weight gain during pregnancy. In a study conducted in coastal areas, it was found that even though family income is low, pregnant women can still get access to nutritious food and adequate health services, so they are able to maintain weight gain according to recommendations. This finding supports the view that income is not the only determining factor in maternal weight gain during pregnancy (19).

Energy intake is not always significantly related to weight gain in pregnant women. This study is in line with research conducted by (20) that although pregnant women with high energy intake tend to experience higher weight gain, there are also pregnant women with low energy intake who experience appropriate weight gain. This shows that other factors outside of energy intake play an important role in determining weight gain in pregnant women and is not in line with research (21), which shows a relationship between total energy intake and weight gain in pregnant women. Consumption of nutritious food and sufficient calories is important to maintain the balance of pregnant women's weight and support optimal fetal growth. A balanced approach to managing energy intake will ensure that pregnant women get enough energy for themselves and their fetuses.

Adequate protein intake is important to support healthy fetal growth and maintain maternal metabolic balance. In several studies, pregnant

women who consumed sufficient protein had a lower risk of experiencing weight loss below recommendations and were more likely to achieve optimal weight gain according to health guidelines. Other studies have also shown that adequate protein intake during pregnancy is associated with excess weight gain in pregnant women (22). It is important to remember that protein intake should be adjusted to individual needs and accompanied by a balanced diet to ensure that pregnant women gain weight according to recommendations. Therefore, pregnant women need to pay attention to adequate protein intake and balance it with the consumption of other nutrients, so that healthy weight gain can be achieved without causing negative impacts on the health of the mother and fetus.

Excessive or unbalanced fat intake can negatively impact maternal weight gain. Adequate fat intake is associated with optimal weight gain during pregnancy, which supports better birth outcomes and infant weight. The study also found that deficiencies in various nutrients are often associated with inappropriate gestational weight gain, making it important for pregnant women to achieve adequate fat and nutrient intakes to prevent excessive or insufficient weight gain (23). Controlling the quality and amount of fat in your diet can help regulate weight gain during pregnancy, thereby reducing the likelihood of complications (24).

Adequate carbohydrate intake can affect the risk of maternal weight gain being below or above the recommendation. Balanced carbohydrate intake supports healthy fetal growth and reduces pregnancy-related complications. Several studies have found that pregnant women who consume good-quality carbohydrates, such as those with a low glycemic index and low added sugar, tend to have better glycemic management, which ultimately reduces the risk of complications related to infant weight (25).

The results of this study are in line with research (26) which states that a significant interaction was found between body weight status and carbohydrate content in food ($P < 0.05$), so that mothers with obesity who consume low-carbohydrate foods have a higher risk of experiencing obesity compared to mothers with obesity (25)

Lack of knowledge about nutritional intake during pregnancy, including ideal body weight, can affect the weight management of pregnant women. Research shows that a lack of knowledge among pregnant women about recommended weight gain guidelines puts them at risk of experiencing underweight or overweight. This is due to the promise of following proper nutritional guidelines, which can lead to regular weight gain, either underweight or obesity. The results of this study are in line with research (27), which showed that nutritional knowledge of pregnant women affects

weight gain during pregnancy. Several studies have also shown that this lack of knowledge increases the risk of inappropriate weight gain. Research in Australia shows that many pregnant women have inadequate knowledge about how to safely manage weight gain, such as mistaken beliefs about organic diets or drinking more fruit juice, which are often associated with inappropriate weight management (28).

Physical activity has a significant impact on reducing the risk of pregnancy weight gain being below or above recommendations compared with more vigorous physical activity. Research shows that pregnant women who do physical activity tend to experience better weight management. Physical activity can help maintain the body's energy balance and metabolism, which plays an important role in minimizing the risk of weight-related complications. This study is in line with (29) that physical activity during pregnancy, especially moderate physical activity, has a positive impact on maternal and infant weight management. Physical activity is associated with reduced excessive weight gain during pregnancy and helps maintain weight within a healthy range. In addition, physical activity can improve glucose control, reduce systemic inflammation, and reduce the risk of preeclampsia and other complications.

Support is very much needed by pregnant women. This study is in line with research conducted by (30) showing that increased support from husband or family is associated with increased nutritional intake and optimal weight gain in pregnant women. Family support and attention help pregnant women overcome emesis gravidarum (excessive nausea and vomiting), which often occurs in the first trimester, so that nutritional intake is maintained. Family support plays an important role in influencing weight gain in pregnant women. The involvement of family members, especially husbands, can have a positive impact on maternal health during pregnancy. This study is in line with research conducted by (30, 31) that good family support can reduce the risk of hyperemesis gravidarum.

Pregnancy planning is not significantly related to weight gain according to recommendations in pregnant women with limited information and socio-economic conditions can also hinder the effectiveness of this planning, the results of this study are not in line with research conducted by (32) that mothers who do not plan pregnancy are at greater risk of experiencing weight gain below recommendations compared to mothers who plan their pregnancy, good pregnancy planning is an important step to ensure the health of the mother and fetus during pregnancy. Mothers who plan pregnancy tend to have better knowledge and readiness, including in terms of maintaining nutritional intake and monitoring weight gain optimally. Pregnancy planning allows mothers to

prepare their nutritional status before pregnancy, so that they start pregnancy in a healthy and ideal condition.

Limitations

Limitations of this study include the limited sample, which may not be generalizable to a wider population. Measurement of nutritional intake relies on self-reports, which are susceptible to bias. Other factors that influence weight gain, such as stress or environmental factors, may not be completely under control. Cross-sectional designs limit the ability to infer causal relationships, and data validity may be affected by respondent subjectivity. This study also did not take into account other social, psychological, or medical factors that could influence the results, and the long-term effects of diet or family support may not be fully captured.

Conclusion

Energy, protein, fat, carbohydrate intake, knowledge, family support, and perception have a significant effect on maternal weight gain, while age, education, occupation, income, parity, smoking habits, ANC visits, and Pregnancy Planning are not related to maternal weight gain. Physical activity is the most influential factor on maternal weight gain according to recommendations; the more physically active pregnant women are, the greater their chances of achieving the recommended weight gain during pregnancy.

Recommendations

This study emphasizes the importance of family interventions, health workers, and public health programs in supporting the achievement of recommended maternal weight gain. Education about healthy eating habits, the importance of physical activity during pregnancy, the role of the family, and regular monitoring by health workers are essential to maintain maternal and fetal health by reducing the risk of inappropriate weight gain. In addition, more detailed education programs are needed to improve family knowledge, such as through nutritional counseling, prenatal classes, and physical activity counseling, which are aimed at strengthening family support during pregnancy. Motivation to do appropriate physical activity can help pregnant women achieve the recommended weight gain and optimize maternal and fetal health.

Authors' Contributions

All authors were involved in the conception and design of the study, participated in data collection and analysis, and contributed to writing, revising, and approving the final manuscript.

Ethical Considerations

The protocol for this study has been approved by the

Medical Ethics Committee of Andalas University Padang, West Sumatra, Indonesia, with a code of ethics No: 117 / UN.16.2 / KEP-FK / 2023.

Acknowledgment

The authors would like to thank the Deli Husada Health Institute the Deli Serdang Health Office for their cooperation and support in this research project.

Conflict of Interests

The authors declare that they have no competing interests.

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