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Association of vitamin D and fiber intake with body fat percentage and visceral fat among female factory workers in Pontianak City

Hubungan asupan vitamin D dan serat dengan persentase lemak tubuh dan lemak visceral pada pekerja pabrik Wanita di Kota Pontianak

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Abstract

Low intakes of vitamin D and fiber can lead to increased body fat and visceral fat in female factory workers. This study aimed to assess the intake of vitamin D and fiber in female factory workers and their relationship with body and visceral fat. This study employed a cross-sectional design, involving 114 female factory workers in Pontianak, West Kalimantan, from April to August 2024. Data collection for vitamin D and fiber intake was performed using the SQFFQ, whereas body fat percentage and visceral fat were measured using BIA. Data analysis was performed using Spearman's Rank Correlation test. The results showed that female workers with higher body fat had a lower intake of vitamin D and fiber. There was a significant relationship between vitamin D intake and visceral fat (rs= 0,190; p= 0,022) but no significant relationship with body fat percentage. Fiber intake was weakly inversely correlated with body fat percentage (rs= -0,176; p= 0,030) and visceral fat (rs= -0,176; p= 0,030) in female factory workers. In conclusion, vitamin D intake is positively associated with visceral fat, whereas fiber intake has a weak inverse relationship with body fat percentage and visceral fat in female factory workers in Pontianak. Efforts to increase vitamin D and fiber intake among female factory workers should be made through nutrition education and employee meal programs.

Keywords: Vitamin D intake, dietary fiber, visceral adiposity, female factory workers.

Abstrak

Asupan vitamin D dan serat yang rendah dapat mengakibatkan penigkatan lemak tubuh dan lemak viseral pada pekerja wanita pabrik. Penelitian ini bertujuan untuk menilai asupan vitamin D dan serat pada pekerja wanita pabrik dan hubungannya dengan lemak tubuh dan lemak viseral. Penelitian menggunakan desain cross sectional dengan melibatkan 114 pekerja wanita pabrik yang dilakukan di Kota Pontianak, Kalimantan Barat pada April-Agustus 2024. Pengumpulan data asupan vitamin D dan serat mengunakan SQFFQ, persen lemak tubuh dan lemak viseral menggunakan BIA. Analisis data menggunakan uji Korelasi Rank Spearman. Hasil, pekerja wanita dengan lemak tubuh tinggi memiliki asupan vitamin D dan asupan serat yang rendah. Terdapat hubungan antara asupan vitamin D dengan lemak viseral (rs= 0,190; p= 0,022) namun tidak dengan persen lemak tubuh pekerja wanita. Asupan serat berhubungan terbalik lemah dengan persen lemak tubuh (rs= -0,176; p= 0,030) dan lemak viseral (rs= -0,176; p= 0,030) pada pekerja wanita pabrik. Kesimpulan, asupan vitamin D berhubungan positif dengan lemak viseral, sementara asupan serat memiliki hubungan terbalik yang lemah dengan persen lemak tubuh dan lemak viseral pada pekerja wanita di pabrik Kota Pontianak. Perlu dilakukan upaya untuk penigkatan asupan vitamin D dan asupan serat pada pekerja wanita pabrik dengan cara pemberian edukasi gizi dan penyelengaraan makanan bagi karyawan.

Kata Kunci: asupan vitamin D, serat, lemak viseral, peekrja wanita pabrik

Introduction

Excess body fat is a significant health concern, leading to various metabolic diseases, reduced quality of life, and lower work productivity (Blüher, 2019; Keleszade et al., 2020; Medina-RemÃ ³ n et al., 2018). The increasing incidence of obesity has become a public health problem in various countries, including Indonesia (Freire et al., 2024; Labatjo et al., 2023), particularly among adult women. Adult women, including female workers in factories, who have entered the productive age to work have a high risk of experiencing an increase in body fat, which leads to obesity. Yulia *et al.*, (2022) found that some of the female workers at convection factories in Kudus Regency who were the subjects of the study were overweight by 8,3% and obese by 33,3% based on BMI categories, while if based on percent body fat, 61,1% of female workers were in the obese category and based on waist-hip ratio by 36,8%.

The results of research by Aryatika et al., (2021) found that female factory workers have unbalanced diets leading to insufficient intake of key nutrients like vitamin D and fiber, which can contribute to fat accumulation. Vitamin D deficiency can cause dysregulation of hormones and adipokines, increase inflammation in fat tissue, and decrease insulin sensitivity and lipogenesis activation, all of which contribute to fat accumulation (Mirza et al., 2022; Zakharova et al., 2019). The low vitamin D content in the blood results in increased production of fatty acid synthase, which converts calories into fat (Jennifer, 2022). Nikolova et al. (2024) reported a negative association between vitamin D intake and body fat percentage, particularly in women. Individuals with low vitamin D intake are at a higher risk of deficiency, with studies associating low serum 25(OH)D levels with higher body fat percentage (Al Hayek et al. 2018) and visceral fat (Zhang et al., 2015).

A study found that low fiber consumption can increase the body fat percentage (Rahmala et al., 2021). Ozato et al., (2019)who conducted a two-year observation of the diet of the adult population in Japan found that there was a negative relationship between fiber intake and changes in visceral fat. Water-soluble fibers form a thick liquid in the gastrointestinal tract, slow gastric emptying, limit food and nutrient intake, and reduce the absorption of fat, sugars, and cholesterol (Septianti & Mintarsih, 2020; Ye et al., 2022). Indigestible fiber is fermented by gut microbiota to produce SCFA (Han et al., 2020; Zamanillo-Campos et al., 2022). As signaling molecules in energy and fat metabolism, SCFA regulate appetite and satiety hormones, improve insulin sensitivity, suppress fat formation, and activate G Protein-Coupled receptors to promote fat burning (Han et al., 2020).

Various studies have been conducted to assess nutrient intake in relation to body and visceral fat in children, adolescents, and adults; however, few have analyzed a specific group, such as female factory workers. Analysis of nutrient intake focuses on macronutrients but not on micronutrients such as vitamin D and fiber intake. Yosephin et al., (2016) found that the prevalence of vitamin D deficiency among female workers in Indonesian garment factories was 47,4%. Puryaningtyas (2020) found that 55,9% of female workers in Surakarta textile factories had deficient fiber intake. Female factory workers have a high risk of vitamin D deficiency owing to inadequate intake and less exposure to sunlight because they work more indoors. Likewise, female factory workers also have a risk of insufficient fiber intake due to a poor diet. Lack of vitamin D and fiber intake increases the risk of increased body fat and visceral fat in female factory workers, which affects their nutritional status and health. This can reduce their productivity levels, which in turn reduces the company's profits (Al Rahmad, 2023).

However, no study has assessed Vitamin D and fiber intake and their relationship with percent body fat and visceral fat in female factory workers. Therefore, this study aimed to evaluate the adequacy of vitamin D and fiber intake in female factory workers, and the relationship between vitamin D intake and percent body fat and visceral fat.

Methods

This was an observational analytical study with a cross-sectional design that allowed data collection from many subjects and variables simultaneously. The research was conducted in Pontianak City, West Kalimantan Province, from April to August 2024.

A total of 114 female workers were sampled using a Multistage Sampling technique, which involved several sampling techniques to obtain a representative sample of the population of female factory workers in Pontianak City. In the first stage, cluster sampling was conducted for industrial companies in Pontianak City based on the categories of large, medium, and small industries. The industrial companies selected as research samples were in large and medium categories. From the category of industry types, industrial companies were selected by random sampling by considering the proportion of each type of industry. The number of industrial companies was then selected based on a ratio of 1:2 to two large industrial companies and four medium industrial companies. The second stage used a proportional random sampling technique to determine the number of samples in each industrial company, resulting in 66 samples from large industrial companies and 48 samples from medium industrial companies. In the third stage, sample selection was conducted using purposive sampling based on the inclusion and exclusion criteria. Purposive sampling techniques were used to minimize bias and ensure that the sample was in accordance with the research objectives. In this study, the exclusion criteria included several factors that could affect body fat. The inclusion criteria were age 18-45 and work in production, while the exclusion criteria were currently running a diet program, being pregnant, and having been diagnosed with degenerative or metabolic diseases, such as DM, heart disease, and kidney and liver function disorders.

Vitamin D and fiber intake were assessed using the SQ-FFQ questionnaire, which was then analyzed using a nutrition survey software. The SQ-FFQ questionnaire was used to assess intake over a one-month period with 122 food items. The SQ-FFQ questionnaire was validated by comparing it with the 2x24 hour Food Recall as the gold standard. Validation was performed using Pearson Product Moment and Rank Spearman correlation tests. The results showed a strong correlation between fiber intake ($r = 0{,}951$, $p < 0{,}01$) and vitamin D intake ($r = 0{,}665$, $p < 0{,}01$).

Percent body fat and visceral fat were measured using Omron Krada Scan HBF-375 Bioelectrical Impedance Analysis (BIA). Body fat measurements were taken before rest time so that workers were in a fasting state (3-4 hours) before measurement. We also ensured that the workers were sufficiently hydrated. The BIA tool is easy to operate and mobilize, safe, and capable of measuring body composition with sufficient accuracy, making it suitable for use in field studies. The data collection procedure began with an explanation and signing of informed consent, and then collected data on sample characteristics, body fat measurements, and food intake.

Univariate data analysis included the frequency distribution of the sample characteristics, vitamin D intake, fiber intake, and body fat. Bivariate analysis was used to determine the relationship between vitamin D and fiber intake, with percent body fat and visceral fat. Before analysis, normality tests were conducted using the Kolmogorov-Smirnov test, which showed that vitamin D intake data with percent body fat ($p = 0{,}018$) and visceral fat ($p = 0{,}006$) were not normally distributed, and fiber intake data with percent body fat ($p = 0{,}015$) and visceral fat ($p = 0{,}014$) were not normally distributed. The statistical test used was the Spearman rank test using SPSS 24 software. The study was ethical approval No: 347/II/HREC/3034 from the Health Research Ethics Committee of Dr. Moewardi General Hospital.

Result and Discussion

This study included 114 female factory workers from various industries in Pontianak City, most of whom were aged between 18-27 years (55,3%). The majority of female workers had graduated from senior high school (59,6%). Based on the nutritional status category according to BMI, most female workers had a normal nutritional status (48,2%) and were overweight and obese (44,7%).

Table 1. Characteristics of female factory workers in Pontianak City

Characteristics	n	%
Age (years)		
18-27	63	55,3
28-37	26	22,8
38-45	25	21,9
Education Level		
Elementary school	16	14
Middle school	12	10,5
High school/equivalent	68	59,6
Higher Education	18	15,8
BMI		
Skinny	8	7
Normal	55	48,2
Overweight	20	17,5
Obesity	31	27,2
Percent Body Fat		
Normal	29	25,4
Moderately High	11	9,6
High (Overweight)	19	16,7
Very High (Obese)	55	48,2
Visceral Fat		
Normal	95	83,3
High	19	16,7
Vitamin D Intake		

<15 μg/day	109	95,6
>15 μg/day	5	4,4
Vitamin D Intake Adequacy (%RDA)		
Deficit	104	91,7
Simply	10	8,3
Fiber Intake		
<30 grams/day	114	100
Fiber Intake Adequacy (%RDA)		
Deficit	114	100

Regarding body fat, 64,5% of female workers had high body fat and 48,2% were in the very high body fat category, However, despite having high body fat, almost all female workers had a normal visceral fat content (83,3%). Most female workers had a low daily vitamin D intake (95,6%) compared to the nutrient adequacy level (RDA), which was below 15 μg/day and fell into the deficit category (meeting <80% of intake requirements), with an average vitamin D intake of 3,7 μg/day. All female workers had a low fiber intake and were in the deficit category (Table 1).

Table 2. Fiber and vitamin D intake of female factory workers based on body fat and visceral fat

Anthropometric Status	Vitamin D intake μg/day		Vitamin D Intake Adequacy (%RDA)		Fiber Intake Gram/day		Fiber Intake Adequacy (%RDA)	
	< 15	≥15	Deficit	Simply	<25	≥25	Deficit	Simply
Percent body fat (%)								
Normal	93,5	2	28	3	100	0	100	0
Moderately High	78,6	3	11	3	100	0	100	0
High	84,2	3	16	3	100	0	100	0
Very High	98,2	1,8	55	1	100	0	100	0
Visceral Fat (%)								
Normal	91	9	90	10	100	0	100	0
High	20	0	20	0	100	0	100	0

Female workers with both normal and high body fat levels had low vitamin D intake and were in the deficit category. Almost all (98,2%) female workers with very high body fat had a low vitamin D intake. Most (91%) female workers with normal visceral fat also had low vitamin D intake, whereas all workers with high visceral fat had a vitamin D intake that was lower than the daily vitamin D requirement. Female workers with normal or high body fat and visceral fat intake had low fiber intake and were in the deficit category (Table 2).

Table 3. Average vitamin D and fiber intake of female factory workers by percent body fat and viseral fat

Anthropometric Status	Vitamin D (μg/day)					Fiber (grams/day)				
	Average	Min	Max	Med	SD	Average	Min	Max	Med	SD
Percent Body Fat										
Normal	3,9	0,2	20,9	1,8	5,3	7,5	1,4	22,9	5,6	5,6
Moderately High	6,3	0,1	20,3	2,9	7,4	5,8	0,8	16,8	3,9	5,2
High	3,8	0	20,5	1,3	6,1	5,1	0,2	18,1	4,2	4,4
Very High	2,9	0	20,5	1,8	3,4	5,6	0,95	16,8	4,5	4,3
Visceral Fat										
Normal	3,9	0	20,9	1,8	5,3	6,3	0,2	22,9	4,5	5,1
High	2,5	0,1	8,2	1,8	2,2	4,8	0,95	11,6	4,5	2,7
Total	3,7	0	20,9	1,8	4,9	6,05	0,2	22,9	4,5	4,8

The mean vitamin D intake of female workers who have a normal body fat percentage (3,9 μg/day) is higher than the mean vitamin D intake of female workers who have a high body fat percentage (high 3,8 μg/day, very high 2,9 μg/day). While the average vitamin D intake of female workers who have normal visceral fat (3,9 μg/day) is higher than that of workers who have high visceral fat (2,5 μg/day). The higher the percentage of body fat, the lower is the average vitamin D intake. The same finding was also found for fiber intake in female workers, where the average fiber intake of workers with a normal body fat percent (7,5 g/day) was higher than that of workers with a high body fat percentage (moderately high 5,8 g/day, high 5.1 g/day, very high 5,6 g/day). Female workers with normal visceral fat (6,3 g/day) had a higher average fiber intake than those with high visceral fat (4,8 g/day) (Table 3).

Statistical test results showed that there was no association between vitamin D intake and percent body fat in female factory workers (p=0,111; r= 0,115), but there was a significant relationship between vitamin D intake and visceral fat in female factory workers with a weak positive relationship (p=0,022; r= 0,190). There was a significant relationship with a weak negative relationship between fiber intake and body fat (p=0,030; r=-0,176), and between fiber intake and visceral fat (p=0,030; -0,177) in female factory workers (Table 4).

Table 4. Associations of vitamin D and fiber intake with body fat and visceral fat

	Vitamin D (μg/day)		Fiber (gram/day)	
	r_s	p-value	r_s	p-value
Body Fat	0,115	0,111	-0,176	0,030
Visceral Fat	0,190	0,022	-0,177	0,030

Vitamin D Intake and Body Fat

In this study, it was found that more than 90% of female factory workers in Pontianak City had deficient vitamin D intake, with an average daily vitamin D intake that was less than the recommended Nutritional Adequacy Rate (RDA) and average daily requirement. Similar results were reported by Yosephin et al. (2016), who found that 99,4% of female workers in one of the garment factories in Indonesia were deficient in Vitamin D intake. The average daily vitamin D intake of female workers in this study was 3,7 μg/day, only meeting an average of 27,5% of vitamin D requirements. The average daily intake of vitamin D in female workers with normal body fat and visceral fat was higher than that in workers with high body fat and visceral fat. The higher the body fat, the lower is the average vitamin D intake. Similar to the results of this study, but in a different population, Risanti et al. (2024) on students of one of the universities in Indonesia also found similar results in that the average vitamin D intake of students who have normal body fat is higher than that of students who have high body fat. The results of statistical tests showed that there was no relationship (P>0,05) between vitamin D intake and body fat but there was a weak positive relationship with visceral fat (p=0,022, r = 0,190) in female workers.

The low variability of vitamin D intake may have affected the ability to identify significant results in this study. Because vitamin D intake tends to be homogeneous, female factory workers with normal or high percentages of body fat and visceral fat have low vitamin D intake. This is supported by the results of Correa-Rodríguez et al. (2020), but in a different population, who also found no association between vitamin D intake and percent body fat in children and adolescents in Spain. In this study, only 9,2% of the participants met the daily adequacy of vitamin D. The results of research by Tayyem et al. (2019), which showed that there is a relationship between vitamin D intake and body fat and visceral fat in adult individuals in Jordan. Other studies have shown different results from this study, where there was an association between vitamin D intake and body fat and visceral fat. Such as the results of research Vázquez-Lorente et al. (2025) which shows that there is an association between vitamin D intake with body fat and visceral fat in the late adult population in Spain. There are several different factors in this study that can explain the relationship between vitamin D intake and body fat, namely, differences in population, larger sample size, and research methodology with a longitudinal approach.

The weak association between vitamin D intake and visceral fat indicates that a decrease or increase in vitamin D intake does not directly affect the visceral fat. It is possible that other factors, such as diet, intake of other nutrients, and physical activity, also affect visceral fat, which were not discussed in this study. Due to low vitamin D intake, the female factory workers in this study were at risk of vitamin D deficiency. This risk may increase because they work indoors for a long time, namely for eight hours a day in a week (six days), so that they get less exposure to sunlight. However, the focus of this study was only on vitamin D intake in female factory workers, not on vitamin D deficiency, and this study can serve as a basis for future research. Low vitamin D intake can result in low serum 25(OH)D levels, which is the active form of vitamin D in the body. Several studies such as Asakura et al. (2020) in Japanese adults, Cabral et al. (2018) in Portuguese adolescents and Al Hayek et al. (2018) in Lebanese adults confirmed the association of low vitamin D intake with low serum 25(OH)D.

Many studies have been conducted that found a significant relationship between serum 25(OH)D levels and body fat and visceral fat in populations in various countries, especially women. As in the results of Al Hayek et al. (2018), female university employees in Lebanon who are not vitamin D deficient have a lower average percent body fat than women who are vitamin D deficient. The results of a study by Shantavasinkul et al. (2015) showed that the Thai adult population with vitamin D deficiency had a higher percentage of body fat. The results of the study Zhang et al. (2015)found that increased visceral fat was associated with a higher risk of vitamin D deficiency in adult women in China. The results of the study Paek et al. (2017)also found that there was a negative relationship between serum 25(OH)D and visceral fat in Korean women. Based on the results of the above studies, it can be assumed that the women in the study may be deficient in vitamin D intake, although there are other influential factors, such as sun exposure. Differences in population characteristics and place of residence lead to differences in body composition and consumption patterns of vitamin D-source foods, which affect the level of vitamin D intake and its association with body and visceral fat. Differences in methods of assessing vitamin D intake can also affect the level of vitamin D intake, which affects the significance and strength of the relationship between the body and visceral fat. In this study, low vitamin D intake in female factory workers was due to the lack of consumption of vitamin D source foods, such as vitamin D-rich fish, meat, milk, and fortified dairy products. In addition, the absence of a food organization for factory workers or the provision of healthy Kanti caused workers to adopt a poor diet, resulting in an imbalance in nutrient intake.

Various mechanisms can explain the role of vitamin D in increasing the body fat. Vitamin D plays a role in the energy metabolic system and regulates cell regulation in adipose tissue, including adipocyte differentiation, adipogenesis, and inflammation (Chattranukulchai & Nimitphong, 2022; Rachmawati et al., 2022; Soares et al., 2014). Vitamin D deficiency can result in impaired insulin sensitivity, activated lipogenesis, and increased body fat mass (Zakharova et al. 2019). Vitamin D can suppress PTH, resulting in an increase in intracellular calcium, which can prevent fat accumulation in adipose tissue. Lipogenesis does not occur by preventing the entry of calcium into adipocytes and stimulates catecholamines to induce lipolysis (Rachmawati et al., 2022). Low vitamin D and calcium content results in increased production of the enzyme fatty acid synthase, which converts calories into fat (Jennifer, 2022; Rachmawati et al., 2022). Vitamin D also plays a role in insulin sensitivity, secretion, and sensitivity of tissue insulin, depending on the Ca2 + mechanism, while vitamin D regulates intracellular Ca2 + concentration and its passage through the membrane (Zakharova et al., 2019). Insulin plays a role in energy metabolism and prevents fat accumulation (Soares et al. 2014). Several preclinical studies have also reported that vitamin D modulates leptin and adiponectin, which play a role in glucose and fat metabolism (Park & Han, 2021; Zakharova et al., 2019). Leptin regulates appetite and hunger, and vitamin D can inhibit leptin synthesis such that vitamin D deficiency can increase appetite and energy intake, which can then lead to body fat accumulation (Bodzsar & Zsakai, 2014; Zakharova et al., 2019).

Fiber Intake and Body Fat

The results of this study showed that all female factory workers in Pontianak City lacked fiber intake, with an average daily intake that was less than the recommended Nutritional Adequacy Rate (RDA). Puryaningtyas (2020) found similar results in that female workers in one of the textile factories in Surakarta had low fiber intake (55,9%). The low fiber intake of these female workers is due to a diet that consumes fewer fiber-source foods such as vegetables and fruits. The results of research by Aryatika et al. (2021) found that female garment factory workers in Bogor consumed less fruit and vegetables which were also associated with the incidence of obesity in female workers.

Low fiber intake was found in female workers with normal or high body fat and visceral fat. The average daily fiber intake of the female workers in this study was 6,05 g/day, meeting only 19,6% of the fiber intake requirements. Similar to this study, but in a different country population, Angeles-Agdeppa and Custodio (2020) found a low average fiber intake of 8 g/day in factory workers in the Philippines. Female factory workers with high body fat and visceral fat had a lower average daily fiber intake than those with normal body and visceral fat. Similar results were shown in another study with a different population; Hadrévi *et al.* (2017) reported that female health workers in Denmark who had high body fat had lower fiber intake compared to those with normal body fat.

The results of the statistical analysis in this study showed a weak negative relationship between fiber intake and percent body fat (P=0,030; rs= -0,176) and visceral fat (P=0,030; rs=-0,177). The weak association between fiber intake and body fat and visceral fat indicates that a decrease or increase in fiber intake does not directly affect the body and visceral fat. It is possible that other factors, such as diet, intake of other nutrients, and physical activity, also affect body fat and visceral fat, which were not discussed in this study. Several studies are similar to this study, but with populations in different countries. As in the research results of Renall *et al.*, (2024) found that there was a strong negative relationship between fiber intake with percent body fat and visceral fat in European women. The results of the study Gibson *et al.*,(2019)also showed that high fiber intake was associated with low percent body fat in the adult population in England. The results of a study by Merritt *et al.* (2024)found a negative relationship between fiber intake and visceral fat in the adult population in America. Different results were reported by Ozen *et al.* (2020), who found a weak positive relationship between fiber intake and percent body fat in the adult population in Europe. Although the same research method was used, the strength of the relationship between fiber intake and body and visceral fat in this study and some of the above studies are different. Differences in population characteristics and place of residence cause differences in body composition and food consumption patterns, which affect the level of fiber intake related to body and visceral fat. In addition, differences in food intake assessment methods can also cause differences in fiber intake levels that affect the strength of the relationship between body fat and visceral fat. Sample size can also affect the level of association; the larger the sample size, the more likely it is to find a statistically significant association and a stronger level of association.

The unavailability of food services for factory workers and the provision of healthy canteens cause workers to adopt a poor diet, resulting in inappropriate needs and imbalances in nutrient intake, including fiber. Adequate fiber intake is important for female factory workers to maintain health and prevent an increase in body fat, so that they can maintain or increase work productivity. Nutritional interventions are needed to increase fiber intake among female factory workers. Nutrition education programs for female factory workers can be carried out by working with nutritionists to increase workers' knowledge about the importance of fiber consumption and food selection of fiber sources, so that there is a change in eating behavior for the better. Provision of food for workers is recommended so that the intake of nutrients can be met according to their needs. However, this can be adjusted to the factory's ability, because organizing meals requires large operational funds. Another alternative is to collaborate with other parties to provide a healthy canteen in the factory environment so that workers can access safe and hygienic nutritious foods.

There are several mechanisms by which low fiber intake can lead to increased body and visceral fat. Fiber has various important functions in energy and fat metabolism, so a lack of fiber intake can cause metabolic disorders that support the acceleration of body fat and visceral fat accumulation. Adequate fiber intake helps reduce and prevent fat accumulation by increasing satiety by increasing the viscosity and volume of food, slowing down the process of food digestion (Ye et al., 2022), binding and removing fat from the digestive tract (Sardi et al., 2021), helping to increase insulin sensitivity (Zeinabi et al., 2023), and increasing the fermentation of gut microbiota to produce SCFA (Han et al., 2020; Zamanillo-Campos et al., 2022). SCFA functions as a signaling molecule in processes and pathways in energy and fat metabolism, where SCFA helps in the regulation or modulation of appetite and secretion of anorexic hormones (Akhlaghi, 2024), improves insulin sensitivity, reduces lipogenesis (fat formation) in the liver and adipose tissue (Bozzetto et al., 2018), and activates GPR receptors (G Protein-Coupled Receptors) to increase fat oxidation and regulate gene expression related to energy and lipid metabolism (Han et al., 2020). Therefore, fiber deficiency can increase food intake and absorption of fat in the gastrointestinal tract and decrease insulin sensitivity, resulting in interference in energy metabolism, increased lipogenesis, and decreased fat oxidation, resulting in fat accumulation in the body

Conclusion

The results of this study showed that most female factory workers had low vitamin D intake and all female factory workers had low fiber intake. Vitamin D and fiber intake was found to be low in female workers with normal or high body fat and visceral fat. No association was observed between vitamin D intake and body fat content. However, an association was observed between vitamin D intake and visceral fat in female factory workers. There was an inverse relationship between fiber intake, body fat, and visceral fat in female factory workers.

Recommendations and nutritional interventions should be provided to increase vitamin D and fiber intake in female factory workers in Pontianak City by providing nutritional education through counseling, organizing nutritious meals for workers, and providing healthy canteens and dining rooms. Further research is recommended to study the incidence of vitamin D deficiency and its relationship with body fat in female factory workers and influencing factors, such as sun exposure and supplementation.

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