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Original Article

Empowering Mothers in Childhood Obesity Prevention: A Qualitative Action Research Study Leveraging Home Monitoring and Assistance Strategies in Medan, Indonesia

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Abstract

Background: Childhood obesity results from an imbalance between dietary intake and physical activity. As mothers significantly influence the dietary habits of school-aged children, enhancing maternal awareness of obesity and its prevention is essential. This study aimed to examine how maternal support, combined with home-based weight tracking, can prevent obesity in primary school students.

Methods: This qualitative study employed an action research approach and was conducted in Medan, Indonesia, from March 2019 to December 2021. Data were gathered through in-depth interviews, observations, focus group discussions, weigh-ins, and secondary data analysis. The study involved twelve participants and was conducted in four phases: diagnosis, planning, intervention, and evaluation.

Results: The findings revealed that maternal involvement significantly influences the prevention of childhood obesity. The implementation of the Healthy and Smart Child Nutrition Care Card or "Peduli Gizi Anak Sehat dan Cerdas" (PEGASDAS) served as an effective home-based tool, facilitating the tracking of children's weight and providing tailored nutritional guidance. Throughout the intervention, mothers actively engaged in monitoring their children's dietary habits and weight, leading to noticeable improvements. Specifically, a shift in dietary patterns was observed, with children exhibiting increased consumption of vegetables and protein-rich foods, as recommended through PEGASDAS guidelines. Moreover, regular weight assessments conducted by mothers enabled early detection of potential obesity risks, prompting timely dietary adjustments. This study underscored the critical role of structured maternal support combined with practical monitoring tools in fostering healthier eating behaviors among primary school children.

Conclusions: Maternal participation and the implementation of home-based weight tracking systems, such as PEGASDAS, are effective strategies in preventing obesity among primary school children. This approach supports early intervention by providing continuous nutritional guidance and weight monitoring, which are vital for promoting healthy weight management and reducing obesity risk in children.

Keywords: Pediatric obesity, Feeding behavior, Education, Nutrition assessment, Indonesia

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1. Introduction

Childhood obesity continues to rise, posing direct risks to children's physical and psychological health, necessitating focused preventive measures. Recent data from 2022 reveals staggering figures, with over 37 million children under five and 390 million aged five to nineteen classified as overweight, including 160 million living with obesity (1). Beyond immediate health risks like type 2 diabetes and cardiovascular diseases, childhood obesity profoundly affects bone health, reproductive function, and increases the risk of certain cancers (2, 3). Additionally, it contributes to psychiatric, psychological, and psychosocial disorders during childhood and heightens the risk of developing non-communicable diseases (NCDs) later in life (4, 5).

Meanwhile, in Indonesia, childhood obesity is also on the rise, with 18.8% of children aged five to twelve classified as overweight, including 10.8% in the overweight category and 8.8% as obese (6). Notably, prevalence rates in Sumatra Utara province exceed the national average, emphasizing the urgency for effective intervention strategies. Previous studies emphasized maternal influence as a critical factor in children's dietary habits and activity levels, necessitating targeted interventions (7–9).

Maternal involvement significantly influences children's dietary habits and physical activity, especially during early childhood. Maternal feeding practices, meal patterns, and the home environment significantly influence children's food choices and activity levels, thus exerting a profound impact on their weight status and overall health outcomes (10). Despite this recognition, there exists a notable gap in the literature regarding interventions that actively engage and empower mothers in the prevention of childhood obesity. Lack of practical tools for monitoring child growth limits early detection of obesity risks (11), while maternal knowledge often falls short in determining optimal food choices based on the typical dietary habits of the targeted age group (12).

This study aimed to address the aforementioned gap by introducing Peduli Gizi Anak Sehat dan Cerdas (PEGASDAS) as a novel approach to empower mothers in the prevention of childhood obesity. By providing mothers with a practical tool for home monitoring and assistance, PEGASDAS seeks to enhance their knowledge, skills, and confidence in promoting healthy behaviors among their children. Through a comprehensive evaluation of the effectiveness of maternal assistance and home monitoring facilitated by PEGASDAS, this research endeavored to shed light on the potential of family-based interventions in combating childhood obesity.

This study aimed to establish evidence-based strategies that leverage maternal involvement for more effective childhood obesity prevention. By empowering mothers through home monitoring and assistance strategies, this research not only aimed to promote healthier lifestyles among children but also underscored the importance of family-centered approaches in addressing complex public health challenges. Furthermore, the findings of this study may have broader implications for informing public health policies and practices aimed at reducing the prevalence of childhood obesity on a larger scale.

2. Methods

2.1. Design

This research was qualitative with an action research approach consisting of four stages, namely diagnosing action, planning action, taking action and evaluating action in Figure 1.

a. Diagnostic stage: This stage is conducted to explore maternal practices in monitoring children's weight and to investigate maternal understanding of obesity, its causes, and preventive measures, which are explored through Focus Group Discussions and in-depth interviews. Additionally, an analysis of children's dietary consumption patterns is conducted using a 24-hour dietary recall method. This is done to obtain an overview of their daily food consumption patterns (quantity, types, and frequency of meals).

b. Planning stage: This stage begins with selecting participants and then conducting meetings with mothers of elementary school children with overweight/obesity status. These meetings are held to establish commitments with mothers to monitor their children's weight. In this stage, an analysis of children's dietary consumption is also conducted using Optifood tools, and food recommendations are formulated to generate food choices for children. These activities aim to design specific action plans targeting overweight and obese elementary school children for effective obesity prevention.

c. Implementation stage: This stage involves the implementation of actions over a period of three months. During this stage, mothers monitor their children's weight and implement providing food choices based on Optifood analysis results. Food choice recommendations are provided in the form of Food Choice Cards. Food Choice Cards were distributed once at the start of the intervention. In this implementation stage, mothers also weigh their children once a month. The weight measurement results are recorded in the available columns on the PEGASDAS Card. Additionally, mothers report the results of their children's weight measurements to the researchers via a WhatsApp Group. The PEGASDAS Card, which also contains information about obesity, its causes, and preventive measures, serves as a medium for providing information to mothers.

d. Evaluation stage: This stage is conducted to assess the impact of the intervention. The impact to be assessed includes changes in children's school weight and changes in children's dietary consumption patterns.

2.2. Data Collection

The research was conducted in the city of Medan, Indonesia from March 2019 to December 2021.

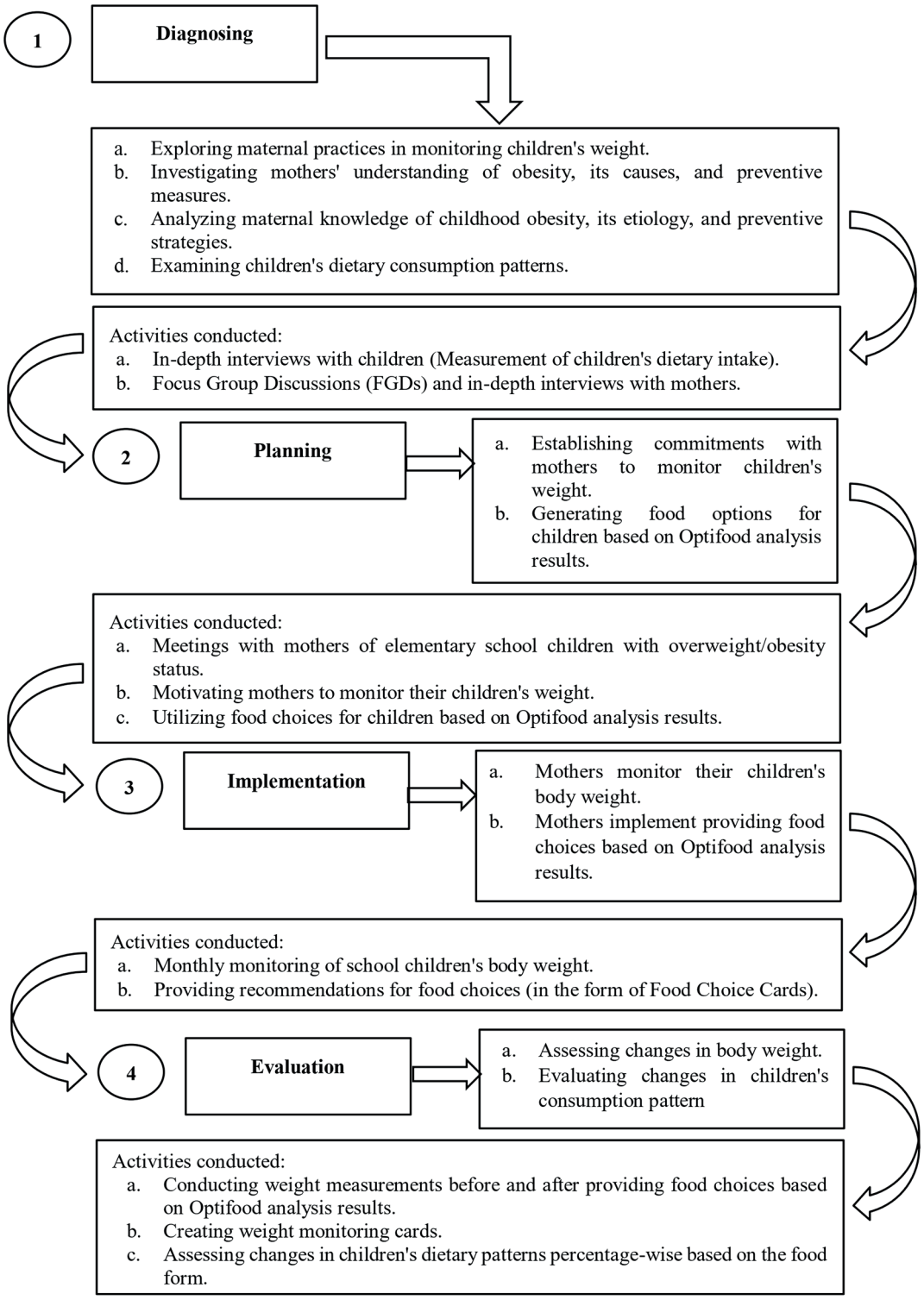

Figure 1: The figure shows the four stages of action research approach.

The participants in this study were divided into two parts. Participants in the first part were mothers directly involved in providing food and weighing their children, and were willing to participate in the study until its completion. Participants in the second part were school children who were the recipients of the intervention. The research instrument utilized in this study was an open-ended questionnaire designed to assess mothers' understanding of obesity, its causes, and prevention strategies.

a. Participant selection and sample size justification: This study employed a qualitative research design, where a sample of 12 participants was deemed sufficient to achieve theoretical

saturation. Theoretical saturation, a concept in qualitative research, refers to the point where additional data no longer contribute to new insights or themes within the study, making the sample size adequate for drawing meaningful conclusions (13). The chosen sample consisted of fourth and fifth-grade students, aged 10 to 11 years, who were capable of accurately recalling dietary consumption through a 24-hour recall method. This age group was selected because they have the cognitive ability to recall dietary intake reliably, which is crucial for accurate data collection in qualitative dietary studies (14). All participants had a body weight exceeding +2.0 Standard Deviations (SD), categorizing them as overweight according to the World Health Organization's growth standards (15).

b. Intervention duration rationale: The three-month intervention period was determined based on the nature of the primary outcome—changes in body weight. Body weight is a sensitive and variable indicator that can respond relatively quickly to changes in dietary intake and physical activity (16). A three-month duration was considered sufficient to observe meaningful trends in weight change and dietary patterns, as supported by previous research indicating that short-term dietary interventions can significantly impact weight outcomes (17). This duration allowed for monthly assessments to track changes in children's consumption patterns and their corresponding effects on weight status.

c. Dietary consumption analysis: To evaluate dietary consumption patterns, WHO Optifood software (Win UI 4.0.14.0 version) was employed, which required food items and dietary patterns, allowing for a comprehensive analysis of nutritional intake. Additionally, Optifood includes a feature to input food prices. This tool enabled the generation of tailored dietary recommendations specific to each target group, such as 7-9 year-olds and 10-12 year-olds, segmented by gender for the latter age group due to their distinct nutritional needs. Food consumption data were collected monthly over the intervention period, with dietary analysis conducted to examine weekly eating patterns, including food types, portion sizes, and the frequency of both main meals and snacks.

d. Formulation of dietary recommendations: Based on the Optifood analysis, dietary recommendations were developed and presented in the form of daily food choice cards. These cards served as practical guides for mothers to structure their children's daily diets, encouraging balanced and nutrient-dense meals. Each card contained specific food items categorized by meal types and portion sizes, tailored to meet the dietary needs identified in the analysis.

Data collection was conducted through interviews, weighing, observation, and Focus Group Discussions (FGD). A single FGD was conducted prior to the intervention to explore mothers' practices in monitoring their children's weight and to understand their perceptions of obesity, its causes, and preventive strategies. The primary goal of the FGD was to establish a shared understanding and agreement regarding the discussed topics, facilitating a basis for effective intervention.

The session involved 12 mothers, each invited to participate in a structured discussion moderated by an experienced facilitator. The FGD began with the moderator posing open-ended questions related to obesity and its prevention. Participants were encouraged to engage in dialogue, sharing their insights and experiences. The moderator played a crucial role in guiding the discussion, ensuring it remained focused and productive while maximizing the collection of diverse opinions within the allocated time frame. The discussion was conducted in a relaxed atmosphere, intentionally designed to allow participants to express their views freely and without pressure, fostering an environment conducive to open and honest communication.

Data processing involved analyzing the responses provided by the informants. The interviews, observations, and FGDs were processed and narrated accordingly. The 24-hour dietary recall was conducted both before and after the intervention to analyze changes in children's consumption patterns. This data collection occurred once a month, exclusively on weekdays, over the three-month intervention period. The decision to collect data on weekdays was based on the observation that children's dietary patterns remained relatively stable during these days. Each monthly 24-hour recall provided insight into dietary behaviors, allowing for consistent tracking of any shifts. Post-intervention dietary patterns were assessed as an average of the three monthly 24-hour recalls, thus offering a comprehensive view

of any changes in eating habits over the course of the intervention.

2.3. Data Analysis

The data analysis was conducted using the "ongoing analysis" technique, which involves analyzing the events that occurred in the field based on the collected data. This analysis aimed to assess the overall improvements, enhancements, and changes observed following the implementation of the action/intervention. To ensure the trustworthiness of the qualitative data, a comprehensive approach was employed, focusing on credibility, transferability, dependability, and confirmability. Credibility was enhanced by prolonging engagement in the field, allowing the researcher to immerse themselves in the participants' environment and gain a deeper understanding of the context. Persistent observation was utilized to identify and confirm key patterns and themes. Additionally, data triangulation was applied by collecting information from multiple sources—such as observations, in-depth interviews, and focus group discussions—thereby validating the consistency of the findings. Data were triangulated to ensure validity. To ensure accuracy, member checking was implemented, where participants reviewed the transcripts and interpretations, confirming that their experiences were accurately captured.

Transferability was addressed by providing detailed, rich descriptions of the research context, participant characteristics, and study procedures. This level of detail enables other researchers to assess the applicability of the findings to different settings or populations, facilitating the generalization of results beyond the immediate study context. These descriptions aimed to provide a clear pathway for replication and adaptation in similar studies.

Dependability was achieved through a systematic audit trail, meticulously documenting each phase of the research process, including data collection, analysis, and decision-making procedures. This audit trail was reviewed by an independent auditor, ensuring that the methodology remained consistent and reliable, regardless of who conducted the research or when it was replicated. Such rigor enhances the stability and consistency of the findings over time.

Confirmability was established by linking the research findings directly to the data collected. All conclusions were drawn from the raw data, ensuring that interpretations were not influenced by the researcher's biases. A systematic cross-referencing process was conducted to compare the emerging themes with the initial field notes and interview data, confirming that the results were a faithful representation of the participants' perspectives.

3. Results

3.1. Participants

The study participants were composed of school children and their mothers, with a focus on addressing childhood obesity. The children included in this research were those identified as either overweight or obese, ensuring that the target population specifically represented the demographic at risk for obesity-related health concerns. To ensure a focused analysis, children suffering from infectious diseases, particularly tuberculosis (TB), were excluded from the study, as their nutritional and health needs could complicate the results related to obesity management.

The school children were selected from fourth and fifth grade, primarily due to their cooperative nature in the data collection process, particularly in providing accurate information regarding dietary intake and participation in weight tracking activities. This age group was ideal for the study as they were able to comprehend and engage with the dietary and health-related interventions implemented throughout the research phases. Furthermore, the study concentrated on mothers of these school children, whose nutritional status indicated overweight or obesity, with 12 mothers serving as informants. The mothers were selected based on their role in managing the household diet and their willingness to participate actively in the study's intervention process.

The study participants consisted of 12 mothers, aged between 36 and 50 years, all of whom had school-aged children. These mothers represented diverse educational backgrounds, including high school (SMA), Diploma Three (D3), Bachelor's (S1), and Master's degrees (S2). Seven participants were full-time homemakers, while the remaining five were employed: two as schoolteachers, one as a lecturer at a private university, and two in

private sector positions. All participants identified as Muslim.

The children of these mothers, comprising seven boys and five girls aged between 10 and 11 years, were enrolled in the fourth and fifth grades. Based on height and weight measurements, all children were classified as overweight, with z-scores ranging from 1.19 to 2.31, indicating an elevated nutritional status.

In terms of geographic location, all participants resided in the same urban area, allowing the research team to implement uniform monitoring and intervention strategies across the study. Despite potential differences in household structure and access to resources, the participants shared similar challenges in managing their children's weight, which was further supported by the implementation of the PEGASDAS for home-based weight tracking and nutritional guidance. This homogeneity in the participant pool provided a consistent framework for evaluating the effectiveness of maternal support in childhood obesity prevention.

3.2. Diagnostic Stage

The initial phase of this research aims to comprehensively diagnose nutritional issues prevalent among elementary school children. Through these methods, researchers seek to gain nuanced insights into the perspectives of both children and their caregivers regarding nutritional habits, particularly focusing on understanding attitudes towards obesity, its perceived causes, and strategies for prevention. Concurrently, dietary recall procedures are implemented to capture the dietary patterns of the children under study, shedding light on the composition, frequency, and variety of their food intake.

Upon analysis, it is revealed that all participating children exhibit overweight status, as indicated by their respective z-scores falling within the range denoting excess nutritional status. The demographic composition of these children, comprising seven boys and five girls aged between 10 and 11 years, underscored the significance of this finding within the context of childhood nutrition. This overweight trend serves as a focal point for subsequent investigations, prompting deeper exploration into the contributing factors and potential interventions.

The qualitative component of the research, including FGDs and in-depth interviews with mothers, provided rich insights into the socio-cultural and behavioral dimensions of childhood obesity. These discussions delve into various thematic areas, including maternal perceptions of childhood obesity, attitudes towards food, roles in meeting children's nutritional needs, and efforts towards obesity prevention. These discussions revealed varying maternal perspectives on healthy weight and barriers to implementing obesity prevention strategies.

Moreover, the findings underscored the multifaceted nature of obesity prevention efforts, highlighting the interconnected roles of caregivers, societal norms, and environmental influences. Challenges such as sedentary behaviors exacerbated by the COVID-19 pandemic and imbalanced dietary patterns emerge as significant barriers to effective prevention strategies. Nonetheless, amidst these challenges, glimpses of resilience and adaptive practices surface, suggesting avenues for targeted interventions and policy initiatives aimed at promoting healthier lifestyles among children.

The findings from the survey on children's dietary consumption revealed that the mean intake of macronutrients (such as energy, protein, fat, and carbohydrates) already surpasses the recommended daily allowance. Similarly, the mean intake of minerals (including iron, calcium, and zinc) also exceeded the recommended daily allowance. These observations underscored the adequacy of children's nutritional intake, as illustrated in Table 1.

3.3. Planning Stage

These results encompassed three main components: providing food options analyzed through the Optifood application, distributing the PEGASDAS, and monitoring children's weight. These actions collectively form a comprehensive strategy aimed at preventing obesity in school-aged children. Now, let's delve into the detailed steps involved in this process.

Firstly, the strategy involves offering food recommendations derived from an in-depth analysis facilitated by the Optifood program. This analysis initiates with a meticulous examination of children's dietary intake patterns. The Optifood analysis outcomes revealed insightful data,

Table 1: Distribution of average macronutrient intake among students in pre- and post-intervention

Nutrient Intake	Mean±SD	
	Pre	Post
Macro:		
Energy (kcal)	2038.77±550.73	2032.91±407.06
Carbohydrates (G)	377.18±121.88	255.55±91.59
Fat (g)	114.82±72.88	81.02±38.13
Protein (g)	94.24±17.33	67.98±22.89
Micro:		
Iron (mg)	14.64±8.18	6.82±3.37
Calcium (mg)	1195.44±761.29	428.82±407.53
Zinc (mg)	11.46±3.33	7.08±2.89
Vitamin A (RE)	1192.08±79.77	527.02±513.79
Vitamin C (mg)	147.38±94.36	61.92±87.15
Vitamin D (mcg)	14.69±10.02	6.82±5.19

indicating that children aged seven to nine exhibit dietary habits encompassing a variety of food groups, including meats, vegetables, legumes, fruits, bread, and snacks. Based on these findings, a tailored daily menu is meticulously crafted to guide mothers in structuring their children's diets. To facilitate ease of reference and implementation, these food recommendations are thoughtfully compiled into user-friendly cards as in Figure 2.

Furthermore, for boys aged 10-12 in elementary school, a similar analytical process is undertaken, building upon the foundation laid with younger children. The Optifood analysis illuminates that these boys frequently consume a diverse range of 65 food types. Specific recommendations are delineated, particularly focusing on adequate protein sources, vegetable intake, and snack consumption. Notably, the frequency of food consumption is adjusted to accommodate the evolving nutritional needs characteristic of early adolescence.

Similarly, Optifood analysis results for girls aged 10-12 unveil common dietary patterns, leading to tailored recommendations reflective of their nutritional requirements. Emphasis is placed

Figure 2: The figure shows the inside of PEGASDAS Card. PEGASDAS: Peduli Gizi Anak Sehat dan Cerdas

on balanced meal choices and prudent moderation in the consumption of certain food items to ensure optimal nutritional intake.

These meticulously curated food recommendations are not merely disparate suggestions but are amalgamated into a coherent and accessible nutrition guide. This guide is designed to empower mothers with actionable insights for daily implementation. Moreover, to facilitate ongoing monitoring and accountability, food choice cards are supplemented with comprehensive checklists. These checklists enable daily evaluation throughout the research period, ensuring adherence to the recommended dietary guidelines as seen in Figure 3.

Concurrently, the production of PEGASDAS cards (Figure 2) adds an additional layer of support and education for parents. These cards serve as educational tools, imparting crucial information on obesity, its associated risks, underlying causes, and effective preventive measures. Furthermore, they serve a practical function by facilitating the monthly tracking of children's weight, thereby enabling proactive intervention and monitoring of progress.

3.4. Implementation Stage

The implementation stage of this research involved the diffusion of adapted innovations based on the findings from the action diagnosis and action plan stages. The stage focused on distributing tailored dietary guidance and implementing regular weight monitoring to track progress. Food recommendations are given once at the onset of the action, aiding mothers in diversifying and regulating their children's daily diets.

Additionally, weight monitoring occurs monthly, recorded in the PEGASDAS, which also includes obesity information and prevention methods. Weight monitoring results are reported to researchers through a dedicated messaging platform, supported by the provision of digital weighing scales to participants, ensuring regular monitoring.

After three months of action and monitoring, notable changes in children's dietary patterns and physical activity levels were observed. Participants reported increased vegetable intake and more regular meal schedules compared to previous habits. Through the provision of food recommendations via choice cards, mothers gain a better understanding of their children's daily dietary needs, promoting balanced nutrition and preventing obesity. This aligned with previous studies indicating the positive influence of family involvement in children's

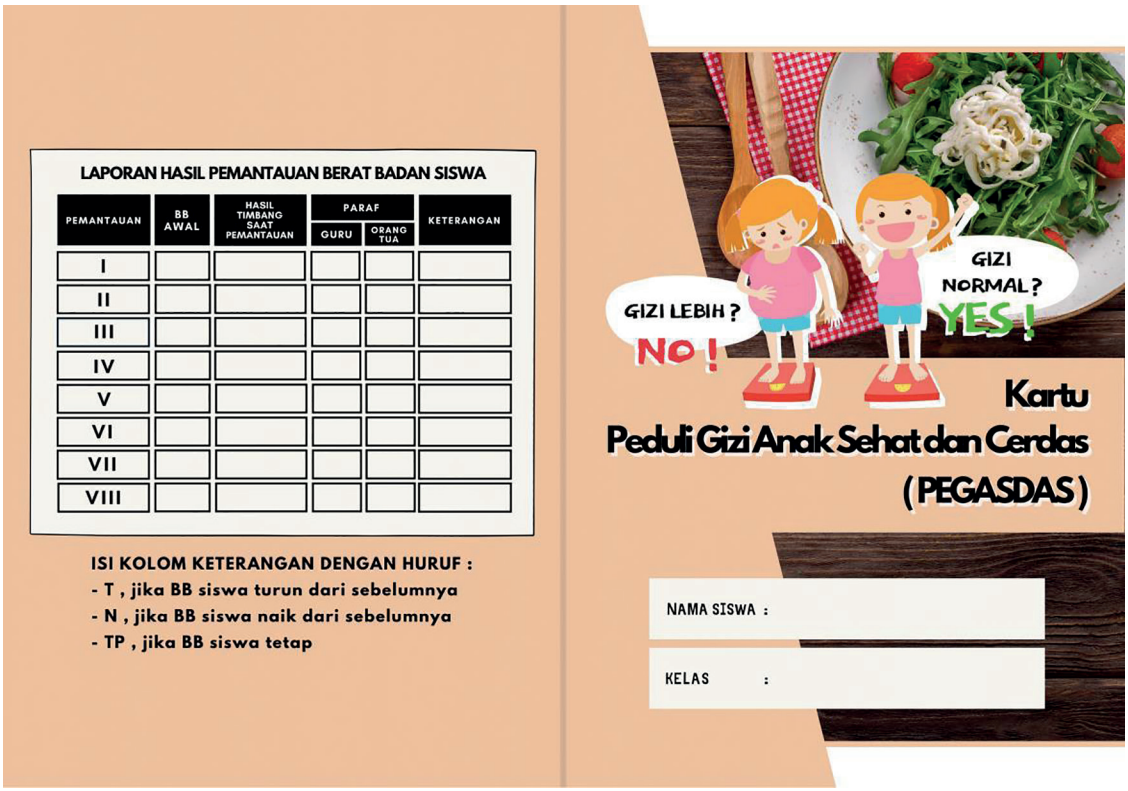

Figure 3: The figure shows the front and back pages of PEGASDAS Card. PEGASDAS: Peduli Gizi Anak Sehat dan Cerdas

dietary behaviors (18, 19). Optifood analysis-based food recommendations were accessible and affordable, facilitating adherence by both mothers and children.

3.5. Evaluation Stage

The evaluation stage of this research, conducted over three months, revealed significant changes in children's food consumption and nutritional status following interventions involving food recommendations and weight monitoring. Before the interventions, children consumed a varied diet, including rice, noodles, bread, sweet potatoes, and corn, alongside diverse protein sources from both animal and plant-based sources. Following food recommendations, a shift was observed towards increased consumption of seafood, tofu, and tempeh, alongside a more diverse intake of vegetables and fruits.

Moreover, the weight monitoring process identified varied changes in each child's weight status. While initial weight gain was observed in the first month, subsequent monitoring indicated improvements in weight status, with overweight children transitioning to normal status. The introduction of food recommendation cards and regular weight monitoring represented novel approaches, fostering increased awareness and attention to children's daily dietary intake and weight status among mothers.

This study underscored the pivotal role of mothers in shaping children's dietary habits and preventing obesity through informed food choices and regular weight monitoring. Furthermore, the dissemination of research findings to a local elementary school and their integration into School Health Unit activities aimed to institutionalize these practices and foster community-wide efforts to combat childhood obesity. By engaging School Health Unit staff and classroom teachers, this initiative aspires to establish a sustainable framework for weight monitoring within the school environment, contributing to broader obesity prevention strategies.

Table 1 illustrates that the macronutrient intake of students decreased following the intervention, particularly in fat and carbohydrate consumption. A decline in micronutrient intake was also observed post-intervention, which can be attributed to the fact that many micronutrients are derived from macronutrient-rich food sources. Consequently, a reduction in the consumption of macronutrient-dense foods may lead to a concomitant decrease in micronutrient intake. This finding highlighted the need for a balanced approach in dietary interventions to ensure that reductions in macronutrient intake do not adversely affect overall nutrient adequacy.

Regular monitoring of children's weight by mothers was conducted monthly as part of a nutritional intervention program. Over a three-month period, significant changes in weight were observed. The average initial weight of participants was 40.6 kg, which increased to 44.2 kg post-intervention, reflecting an average weight gain of 3.6 kg. Table 2 illustrates the detailed weight changes for individual participants, while Figure 4 visualizes the average weight changes.

The bar chart illustrates the mean weight before and after the intervention, highlighting the significant increase in the average weight over the three-month period.

Table 2: Weight changes among child participants in pre- and post-intervention

Child Participant	Weight Before (kg)	Weight After (kg)	Difference (kg)
Child 1	36.1	44.0	7.9
Child 2	43.0	43.2	0.2
Child 3	32.1	35.9	3.8
Child 4	46.9	50.0	3.1
Child 5	45.8	46.0	0.2
Child 6	38.8	43.7	4.9
Child 7	40.2	44.0	3.8
Child 8	37.6	41.2	3.6
Child 9	38.7	44.0	5.3
Child 10	43.4	47.4	4.0
Child 11	41.4	47.9	6.5
Child 12	42.9	43.2	0.3

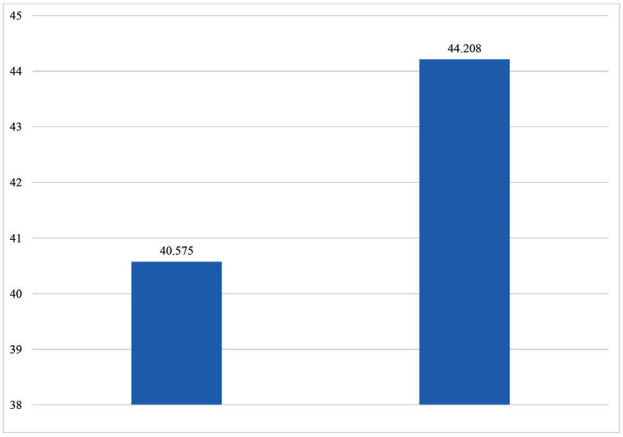

Figure 4: The figure shows the average weight of participants before and after intervention.

To analyze the significance of the weight changes, a paired sample t-test was conducted. The data exhibited a normal distribution, allowing for robust statistical analysis. The results indicated a statistically significant difference in average weight before and after the intervention (P=0.0001, <0.005), as shown in Table 3.

In addition to weight increases, changes in nutritional status were evaluated based on z-scores. After three months, 66.7% (n=8) of the children who were initially classified as overweight transitioned to the normal weight category. Two children remained in the obesity category, while four (33.3%) retained an obese status after intervention. These findings underscored the efficacy of the intervention in improving weight and nutritional status among the majority of participants.

4. Discussion

This study demonstrates the key role of maternal involvement in preventing childhood obesity through home-based weight monitoring and tailored dietary interventions. The use of the PEGASDAS and customized food recommendations helped mothers regulate their children's diets, leading to healthier eating habits and improved weight status.

The success of PEGASDAS lies in its dual function as a monitoring tool and educational resource, enabling early detection of weight changes and providing practical guidance on nutrition. The tailored recommendations, based on Optifood analysis, encouraged mothers to shift their children's diets from nutrient-poor foods to more balanced options, promoting healthier eating patterns. Despite challenges, including increased sedentary behavior, structured meal planning showed positive outcomes in dietary habits. Overall, the combination of maternal support, education, and regular monitoring proved crucial in reducing obesity risks in school-aged children.

4.1. The role of Mothers in Shaping Children's Eating Habits

Mothers serve as primary caregivers and decision-makers when it comes to their children's dietary choices. From infancy, mothers play a central role in determining what foods their children consume, influencing their taste preferences, portion sizes, and mealtime behaviors. Research indicated that parental feeding practices, such as modeling healthy eating behaviors, providing nutritious meals, and creating a positive mealtime environment, significantly impact children's food preferences and dietary habits (20). Therefore, empowering mothers to adopt healthy feeding practices is essential for promoting optimal nutrition and preventing childhood obesity.

The intervention enhanced maternal understanding and management of child nutrition, contributing to positive dietary changes. Indeed, the responsibility for nurturing the dietary habits of school children predominantly falls upon mothers, who serve as the primary architects of family sustenance. Yet, when mothers adeptly navigate their children's dietary choices, the specter of obesity is substantially mitigated. Bahatheg's cross-national investigation underscored the profound impact of parental engagement, revealing that a staggering 96.1% of caregivers conscientiously attended to their children's nutritional needs during lockdowns, yielding a noteworthy 63% prevalence of weight maintenance among children (21). Parental oversight is essential in reducing

Table 3: Statistical analysis of weight differences in pre- and post-intervention

Variable	Mean±SD	Min; Max	P value
Weight Before Intervention	40.57±4.21	32.1; 46.9	0.0001
Weight After Intervention	44.21±3.58	35.9; 50.0	

SD: Standard Deviation

calorie-dense snack consumption, reinforcing the need for promoting healthy dietary practices and regular physical activity (22).

Moreover, familial eating habits profoundly influence children's dietary comportment (23). Exemplary behaviors such as home-cooked breakfasts, packed lunches, and limited snack consumption engender salubrious dietary routines. Cultivating diverse and nutritionally balanced meal choices while eschewing sugary fare fosters robust eating habits (24). Indeed, inculcating a palate for wholesome fare like rice, fish, tofu, and vegetables augurs far greater health dividends than succumbing to the allure of high-fat, high-salt fast foods (25).

Nuryani and Rahmawati's study in Gorontalo Regency corroborated the salience of breakfast routines, highlighting their positive correlation with overall nutritional status. Conversely, detrimental dietary practices not only escalate the risk of childhood obesity but also imperil overall well-being (26). Prasasti and Indrawati's research in Babak Sari Gresik Elementary School further underscored the profound impact of maternal knowledge and attitudes on children's nutritional well-being, illuminating a significant 66% and 34% influence, respectively (27).

Crucially, the practice of regular weight monitoring has gained traction within households, emerging as a cornerstone of pediatric health surveillance. Maternal stakeholders stand as vanguards of transformative change, spearheading the adoption of innovative dietary paradigms and fostering a culture of proactive health management. By instilling a norm of regular weight monitoring, mothers fortify the frontline defenses against childhood obesity, transcending the conventional purview of healthcare institutions and galvanizing a grassroots movement towards holistic well-being (22, 28).

4.2. Comparison with Successful Strategies

The results of this study aligned with existing global evidence highlighting the significance of maternal involvement in preventing childhood obesity. For instance, the *Family Nutrition and Physical Activity Screening Tool (FNPA)* in the United States has proven effective in enabling parents to assess and modify their children's dietary and physical activity behaviors. By providing structured guidance and tools for home-based monitoring, FNPA empowers parents to create supportive environments for healthy growth. Similarly, PEGASDAS demonstrated its potential to facilitate consistent dietary monitoring and weight tracking among school-aged children. Both FNPA and PEGASDAS underscore the importance of equipping parents, particularly mothers, with practical resources to enhance their roles as health advocates within the family (10).

Comparable interventions, such as the *Healthy Start Program* in the United Kingdom, emphasized the provision of parental education on balanced nutrition, portion control, and physical activity. These programs adapt their strategies to the specific needs of families, an approach mirrored in this study through the use of PEGASDAS, which integrates customized dietary recommendations derived from Optifood analysis. The results affirmed that combining education with accessible monitoring tools can significantly influence children's dietary patterns, echoing evidence from the Healthy Start Program, where parental education led to notable improvements in children's dietary practices (23).

In Indonesia, the Keluarga Sadar Gizi (Kadarzi) initiative aims to enhance maternal nutrition awareness through education, yet lacks systematic home monitoring tools. However, programs such as Kadarzi often lack the comprehensive tools needed for systematic home-based monitoring and actionable guidance. PEGASDAS addresses this gap by combining educational materials with an easy-to-use tracking system, enabling mothers to actively monitor their children's progress and make informed nutritional decisions. This integration reinforces findings from prior research in Indonesia, which emphasize the role of maternal education in promoting better nutritional outcomes for children (22, 26).

This study demonstrated the scalability and adaptability of PEGASDAS as a culturally tailored intervention for childhood obesity prevention. By providing mothers with accessible tools and personalized guidance, PEGASDAS exemplifies a family-centered approach that aligns with global best practices. Its dual role as a monitoring and educational resource highlights the centrality of maternal involvement in fostering sustainable dietary and behavioral changes, further supporting

the argument that maternal engagement is an indispensable component of effective childhood obesity interventions.

4.3. Empowering Mothers through Home-based Interventions

To effectively address the challenges faced by mothers and promote healthy eating habits among children, a multifaceted approach integrating home monitoring and assistance strategies is paramount. Drawing from research findings indicated the efficacy of maternal involvement and weight monitoring through tools like the PEGASDAS in preventing obesity among school-aged children, it is imperative to align these strategies with evidence-based practices.

Firstly, nutritional education programs must equip mothers with comprehensive knowledge encompassing balanced nutrition, meal planning, and healthy cooking techniques (29). This educational framework should be augmented with guidance on utilizing tools such as the PEGASDAS for home-based weight surveillance and nutritional guidance. Through workshops, online resources, or personalized home visits by healthcare professionals, mothers can be empowered to make informed food choices aligned with the recommendations provided by the PEGASDAS.

Secondly, practical assistance in meal preparation should not only offer recipe ideas and meal planning templates (30) but also emphasize the integration of PEGASDAS recommendations into daily meal planning. Initiatives such as meal kit delivery services or community cooking classes should incorporate the use of the PEGASDAS to reinforce healthy eating habits and promote obesity prevention among children.

Thirdly, encouraging mothers to create a supportive home environment conducive to healthy eating habits should be underpinned by the principles outlined in the PEGASDAS. Strategies such as limiting the availability of unhealthy snacks, promoting family meals, and establishing positive mealtime routines should align with the nutritional guidance provided by the PEGASDAS. Moreover, integrating child-friendly kitchen gadgets and utensils can facilitate children's participation in meal preparation activities while reinforcing the nutritional recommendations outlined in the PEGASDAS.

Finally, implementing systems for monitoring children's dietary intake should integrate the use of the PEGASDAS as a standardized tool for home-based weight surveillance and nutritional guidance. Mothers can track progress towards healthy eating goals based on the recommendations provided by the PEGASDAS.

Thus, integrating mothers into comprehensive obesity prevention initiatives represents a paradigm shift in public health strategy, harnessing the familial nexus to effectuate lasting change in children's dietary behaviors and safeguarding their future health trajectories.

Clinically, the findings suggested that integrating home-based tools like PEGASDAS into routine care could enhance parental involvement in preventing childhood obesity. Healthcare providers could adopt similar tracking and educational tools to empower families in managing children's nutrition.

Policy-wise, these results highlighted the need for public health initiatives that promote parental engagement in children's weight monitoring and nutrition education. Schools and health authorities could implement similar strategies to combat childhood obesity more broadly, institutionalizing regular monitoring and education within community health programs.

4.4. Limitations

The small sample size and relatively short intervention period of three months limited the generalizability of the findings. Future research should involve larger and more diverse populations with longer follow-up periods to assess the sustainability of the interventions. Moreover, the findings underscored the potential of integrating home-based tools such as PEGASDAS into routine clinical practices for monitoring and guiding nutritional management. Policymakers may also consider adopting similar strategies at the community level to institutionalize regular weight monitoring and nutritional education within public health programs. These interventions could be tailored to diverse cultural and socioeconomic contexts to enhance their scalability and impact on addressing childhood obesity.

5. Conclusions

The PEGASDAS intervention strengthened maternal efforts to promote balanced nutrition and variety in children's diets. Monthly weight assessments have been standardized to facilitate continuous monitoring of children's progress. The findings suggested that mothers are likely to continue monitoring their children's dietary habits and maintain healthier food choices.

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Authors' Contribution

Ernawati Nasution: Contributions to data collection, analysis, and interpretation of results, drafting the manuscript and reviewing it critically. Albiner Siagian: Contributions to analysis and interpretation of results, planning and supervision, aiding in interpreting results, drafting the manuscript and reviewing it critically. Etti Sudaryati: Contributions to data collection, supporting analysis, and reviewing the manuscript critically. Fikarwin Zuska: Contributions to design and supervision, and reviewing the manuscript critically. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work, including the accuracy and integrity of any part of the work.

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Ethical Approval

The Ethics Review Board Committee of Faculty of Nursing, University of North Sumatra, approved the present study with the code of 1958/I/SP/2020. Also, written informed consent was obtained from all participants prior to their involvement in the study, ensuring their voluntary participation and understanding of the research objectives, and procedures.

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