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Research Article

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Efficacy of Intensive Lifestyle Modification with Meal Replacement for Sustainable Weight Loss and Improved Body Composition in Obese Adults: A Retrospective Cohort Study

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ABSTRACT

Purpose: This study aims to evaluate the effectiveness of intensive lifestyle modification (ILM) alone and in combination with meal replacement (MR) on weight loss and body composition among obese individuals. The research also investigates the sustainability of these interventions over 52 weeks.

Design/Methodology/Approach: A retrospective cohort study was conducted involving 702 participants divided into three groups: ILM + MR, ILM only, and a non-ILM control group. Anthropometric and metabolic data were collected at baseline, 8 weeks, and 52 weeks. Outcomes were analyzed using ANOVA and paired t-tests to assess changes in weight, waist circumference, body mass index (BMI), visceral fat, body fat percentages and body muscle percentages.

Findings: The ILM + MR group demonstrated the most significant improvements in weight (-14.43 kg), BMI (-5.54), and waist circumference (-7.41 inches) at 52 weeks ($p < 0.001$), alongside increased muscle mass (+2.33%) and reduced fat mass (-7.54%) [1,2]. The ILM-only group achieved moderate improvements, while the control group exhibited negligible or adverse changes [2]. These results underscore the enhanced effectiveness of combining ILM with MR compared to ILM alone.

Originality/Value: This study provides robust evidence supporting the integration of intensive lifestyle modification with or without meal replacements during the first 8 weeks programs for sustained weight loss and improved body composition. The findings contribute to the development of practical, scalable strategies for addressing obesity in public health settings, particularly in resource-limited environments.

Keywords: Obesity, Intensive Lifestyle Modification, Meal Replacement, Weight Loss, Body Composition

Abbreviations

ILM	:	Intensive lifestyle modification
MR	:	Meal replacement
%Fat	:	Body fat percentage
%Muscle	:	Body muscle percentage

Introduction

Obesity is a growing global health issue, with significant implications for physical, psychological, and economic well-being. The World Health Organization (WHO) reports that the global prevalence of obesity has nearly tripled since 1975, emphasizing the urgency of effective intervention strategies [1]. In Thailand, the prevalence of obesity is among the highest in Asia, with over 42% of the population categorized as obese or overweight, posing a substantial burden on public health systems [1,2]. Obesity is strongly associated with metabolic syndrome,

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type 2 diabetes, cardiovascular diseases, and psychological disorders, making its management a critical health priority [2,3].

Lifestyle modification, including dietary changes, increased physical activity, and behavioral interventions (group therapy), is the cornerstone of obesity management [4]. However, adherence to these programs remains a challenge due to cultural, social, and economic barriers, particularly in resource-limited settings [2,5]. The incorporation of meal replacements (MRs) into lifestyle modification programs has shown promise in enhancing adherence by simplifying dietary adjustments and providing controlled caloric intake [1,3]. Studies have demonstrated the efficacy of MRs in achieving greater weight loss and improved metabolic profiles when combined with lifestyle changes [6,7].

This study evaluates the effectiveness of intensive lifestyle modification (ILM) alone and in combination with meal replacements in achieving sustainable weight loss and improving body composition. By investigating outcomes over a 52-week period, this research provides insights into the potential for integrating ILM and MR interventions into public health strategies, addressing a significant gap in obesity management literature [1,3].

Materials and Methods

Study Design

This study employed a retrospective cohort design to assess the effectiveness of intensive lifestyle modification (ILM) alone and in combination with meal replacement (MR) in obese individuals. Data were collected from a structured intervention conducted between 2022 and 2023. Participants were assigned to one of three groups: ILM + MR, ILM-only, and a non-ILM control group. Anthropometric and metabolic data were obtained at baseline, 8 weeks, and 52 weeks. Ethical approval was granted by the relevant institutional review boards prior to the study [1,2].

Study Participants

The study enrolled 702 participants aged 18–80 years with obesity defined as a body mass index (BMI) $\geq$25 kg/m² or central obesity with waist circumferences exceeding 90 cm for men and 80 cm for women [1,4]. Exclusion criteria included preexisting chronic diseases, ongoing use of medications affecting weight, pregnancy, breastfeeding, and participation in other weight loss programs [2,4]. Participants were allocated evenly across the three groups (1:1:1 ratio).

Baseline demographic data revealed comparable distributions of age, sex, and BMI across groups, ensuring minimal confounding from initial differences [6]. Key characteristics included a mean baseline BMI of 26.85 kg/m² (SD = 5.36) and waist circumference of 35.7 inches (SD = 5.5) across all groups [2,7].

Interventions

Group 1: Intensive Lifestyle Modification with Meal Replacement

Participants in the ILM + MR group received structured nutritional counseling combined with meal replacements (MR). The MR product, a soy-based formula providing 220 kcal per serving, was consumed twice daily in the first 8 weeks, replacing breakfast and dinner [1,7]. Counseling sessions emphasized balanced dietary intake, incorporating high fiber and low glycemic index foods to complement the MRs [4,6,8]. Behavioral modification techniques, including self-monitoring, goal setting, and motivational group therapy, were implemented to enhance adherence [2,9].

Physical activity recommendations included slow walking for 10 minutes after breakfast and 5 minutes after lunch and dinner in the first 8 weeks then along with self-stretching the body every 1 hour [1,8]. Stress management and sleep hygiene were also integral components of the intervention, fostering holistic lifestyle changes [10,11].

Group 2: Intensive Lifestyle Modification Only

The ILM-only group followed a similar protocol, excluding the use of meal replacements. Nutritional counseling sessions focused on maintaining a balanced diet with controlled caloric intake, tailored to individual needs [4,6]. Participants were encouraged to limit processed foods, added sugars, and saturated fats while increasing their consumption of vegetables and lean protein [2,10].

Physical activity and behavioral modification techniques mirrored those in the ILM + MR group, aiming to create sustainable habits [1,5]. Stress reduction and sleep optimization strategies were also included [9,11].

Group 3: Control Group

Participants in the control group did not receive structured interventions. They were provided with general advice on healthy living but did not engage in the supervised ILM protocol or receive meal replacements [4,10].

Outcome Measures Anthropometric and Metabolic Indicators

The primary outcomes were changes in body weight, waist circumference, BMI and secondary outcomes were changes in body composition, including visceral fat, fat mass and muscle mass, assessed at baseline, 8 weeks, and 52 weeks. Weight was measured using a calibrated digital scale, and BMI was calculated as weight (kg) divided by height (m²) [2,6]. Waist circumference was measured at the midpoint between the lowest rib and the iliac crest. Fat mass and muscle mass percentages were determined using bioelectrical impedance analysis, which provided insights into body composition changes [2,7].

Data Collection and Follow-Up

Baseline data were collected according to the participant data recording form in Google form by collecting retrospective data and check body composition 4 times at baseline and at 2, 4, 8, and 52 weeks. The tools used include the Omron body fat meter, model HBF-375 or the Omron body fat meter, model HBF-702T. All measurements were conducted by trained healthcare professionals to ensure consistency and accuracy [6,3].

Participants were contacted regularly through phone calls and online consultations to encourage adherence and monitor progress [10,11].

Statistical Analysis

Descriptive statistics, including means and standard deviations, were calculated for continuous variables, while frequencies and percentages were used for categorical data [2,3]. Differences between groups were analyzed using one-way ANOVA for normally distributed variables and Kruskal-Wallis tests for non-normal distributions.

Paired t-tests assessed within-group changes over time, and post hoc pairwise comparisons with Bonferroni corrections identified significant differences between groups [1,8]. Relative risk reductions for metabolic outcomes were calculated using logistic regression models [3,12].

Propensity score matching was performed to adjust for baseline imbalances in demographic variables such as age, sex, and BMI [1,10]. All analyses were conducted using SPSS version 28, with statistical significance set at $p < 0.05$ [6].

Results

Participant Characteristics

The study enrolled 702 participants evenly distributed across three groups: ILM + MR (n = 230), ILM-only (n = 229), and the control group (n = 219). Participants were predominantly female, with women comprising 78.3% of the ILM + MR group, 81.2% of the ILM-only group, and 79.5% of the control group. The mean age was comparable across groups: 43.6 years in the ILM + MR group, 46.21 years in the ILM-only group, and 41.42 years in the control group. Baseline BMI values were 26.85 (SD = 5.36), 27.58 (SD = 5.12), and 25.14 (SD = 4.90), respectively. Waist circumferences followed a similar pattern, with mean values of 35.7 inches, 36.66 inches, and 33.98 inches [2].

This demographic and anthropometric consistency among groups ensured comparability for evaluating the interventions' outcomes. Importantly, baseline measurements indicated that all groups met the inclusion criteria of obesity, either by BMI or waist circumference standards [1,6].

Table 1: Baseline characteristics of study participants

Baseline Characteristics*	Intervention ILM+MR (230)	Intervention ILM (229)	Control (219)
Sex			
Female	180 (78.3)	186 (81.2)	174 (79.5)
Male	50 (21.7)	43 (18.8)	45 (205)
Age (years)			
Mean±SD	43.6±10.26	46.21±12.72	41.42±14.7
(min-max)	(18-71)	(18-75)	(19-77)
Body weight (kg)			
Mean±SD	69.31 16.31	71.64 16.1	65.02 15.41
(min-max)	43-172	42-156	43-127
Body mass index (kg/m^2)			
Mean±SD	26.85 5.4	27.58 5.12	25.14 4.9
(min-max)	24-56	24-48	24-43
Waist circumference (inch)			
Mean±SD	35.7 5.5	36.6 4.4	33.9 4.7
(min-max)	32-62	32-56	32-47
Blood group			
A	50 (21.7)	48 (21)	29 (13.2)
B	71 (30.9)	58 (25.3)	74 (33.8)
O	98 (42.6)	106 (46.3)	100 (45.7)
AB	11 (4.8)	17 (7.4)	16 (7.3)

SD Standard deviation
* No statistically significant differences were observed between the intervention and control groups regarding all baseline characteristics (p-value > 0.05)

Anthropometric and Body Composition Changes Primary Outcomes at 8 Weeks

The ILM + MR group demonstrated significant improvements across all metrics compared to the other groups. Mean weight decreased by 7.58 kg ($p < 0.001$), while BMI reduced by 2.94 units. Waist circumference dropped by 4.37 inches, and visceral fat decreased by 3.51 units. Muscle mass increased by 1.88%, emphasizing the preservation of lean mass despite weight loss [2,6].

The ILM-only group also experienced notable reductions, with mean weight loss of 6.96 kg, BMI reduction of 2.68, and a waist circumference decrease of 3.52 inches. Muscle mass increased by 1.22%, reflecting a beneficial composition shift. However, the magnitude of changes was less pronounced than in the ILM + MR group [2,5].

In contrast, the control group exhibited negligible improvements. Weight increased slightly (+0.34 kg), waist circumference rose marginally (+0.086 inches), and BMI remained virtually unchanged (+0.14). Fat mass and visceral fat increased slightly, with muscle mass decreasing by 1.92%, highlighting the deterioration of body composition without structured interventions [2].

Table 2: Comparing outcome measurements between the intervention group and control group at start periods

Group	n	Mean	S.D.	p-value	Mean Difference	
					ILM	Control
Body weight (kg)						
ILM+MR	230	69.31	16.51	<0.001	-2.33 (p = 0.266)	4.29 (p = 0.013)
ILM	229	71.64	16.1		-	6.62 (p <0.001)
Control	219	65.02	15.41		-	-
Waist (inch)						
ILM+MR	224	35.7	5.5	<0.001	-0.95 (p = 0.098)	1.73 (p = 0.001)
ILM	229	36.66	4.4		-	2.68 (p <0.001)

Control	219	33.98	4.76		-	-
Body mass index (kg/m^2)						
ILM+MR	230	26.85	5.36	<0.001	-0.74 (p = 0.273)	1.71 (p = 0.001)
ILM	229	27.58	5.12		-	2.45 (p <0.001)
Control	219	25.14	4.9		-	-
Visceral fat						
ILM+MR	107	11.08	6.75	<0.001	-0.97 (p=0.517)	3 (p <0.001)
ILM	70	12.05	6.92		-	3.97 (p <0.001)
Control	219	8.08	5.71		-	-
% FAT						
ILM+MR	84	32.29	6.77	0.004	-0.84 (p=0.74)	1.99 (p=0.049)
ILM	56	33.13	7.02		-	2.82 (p=0.012)
Control	219	30.31	6.35		-	-
%Muscle						
ILM+MR	82	25	3.2	0.013	0.068 (p=0.993)	-1.1 (p=0.043)
ILM	58	24.93	4.06		-	-1.16 (p=0.065)
Control	219	26.1	3.5		-	-

Table 3: Comparing outcome measurements between the intervention group and control group at follow-up periods after 8 weeks

Group	n	Mean	S.D.	p-value	Mean Difference	
					ILM	Control
Body weight (kg)						
ILM+MR	227	61.88	14.48	0.056	-3.16 (p = 0.063)	-2.99 (p = 0.245)
ILM	221	65.04	14.64		-	0.17 (p = 0.996)
Control	87	64.87	15.97		-	-
Waist (inch)						
ILM+MR	169	31.89	4.72	<0.001	-1.4 (p = 0.008)	-2.26 (p = 0.001)
ILM	214	33.29	4.16		-	-0.86 (p = 0.299)
Control	87	34.15	5.12		-	-
Body mass index (kg/m^2)						
ILM+MR	227	23.96	4.69	0.023	-1.09 (p = 0.041)	-1.27 (p = 0.088)
ILM	228	24.28	6.28		-	-1.75 (p = 0.954)
Control	87	25.23	5.18		-	-
Visceral fat						
ILM+MR	76	7.27	5.65	0.389	-1.13 (p=0.565)	-1.14 (p = 0.41)
ILM	41	8.39	4.82		-	-0.02 (p = 1)
Control	87	8.41	6.11		-	-
% FAT						
ILM+MR	66	32.91	37.98	0.795	3.01 (p=0.804)	1.92 (p=0.867)
ILM	36	29.9	7.41		-	-1.09 (p=0.969)
Control	87	30.99	6.5		-	-
%Muscle						
ILM+MR	65	26.98	3.55	0.19	0.61 (p=0.683)	1.08 (p=0.163)
ILM	38	26.37	4.04		-	0.47 (p=0.782)
Control	87	25.9	3.39		-	-

* p = p-value

Secondary Outcomes at 52 Weeks

Long-term follow-up revealed sustained benefits for both intervention groups. The ILM + MR group achieved the most substantial results, with mean weight loss of 14.43 kg, a BMI reduction of 5.54, and a waist circumference decrease of 7.41 inches ($p < 0.001$). Fat mass reduced by 7.54%, and muscle mass increased by 2.33%, confirming the intervention's effectiveness in improving body composition over time [2,7].

The ILM-only group maintained positive outcomes, though with smaller magnitudes than the ILM + MR group. Mean weight loss was 8.56 kg, BMI reduction was 3.25, and waist circumference decreased by 4.25 inches. Fat mass reduced by 4.45%, and muscle mass increased by 1.91% [2,6].

The control group continued to show minimal progress. Weight remained largely unchanged (+0.35 kg), waist circumference increased slightly (+0.11 inches), and BMI showed a negligible rise (+0.14). Fat mass increased by 0.58%, and muscle mass saw an insignificant change (+0.014%). These results reinforce the ineffectiveness of unstructured advice for managing obesity [2,9].

Table 4: Comprehensive outcome measurements on the intervention group and control group at follow-up periods after 52 weeks

Changes in body composition	Mean	Mean difference	S. D (Mean difference)	95% confidence interval	P-value
ILM+MR (230)					
Body weight (kg) (n = 160) - Baseline	71.31	14.43	10.95	11.6-17.26	<0.001
- 52 weeks	56.89				
Waist (inch) (n = 154) - Baseline	36.38	7.41	4.09	6.3-8.5	<0.001
- 52 weeks	28.97				
Body weight (kg) (n = 147)					
- Baseline	71.69	8.56	4.55	7.81-9.3	<0.001
- 52 weeks	63.13				
Waist (inch) (n = 143)					
- Baseline	36.82	4.25	2.1	3.9-4.59	<0.001
- 52 weeks	32.57				
Body mass index (n = 147)					
- Baseline	27.64	3.25	3.66	2.66-3.84	<0.001
- 52 weeks	24.39				
Visceral fat (n = 38)					
- Baseline	11.23	4.25	2.49	3.15-5.36	<0.001
- 52 weeks	6.98				
%FAT (n = 30)					
- Baseline	32.27	4.45	2.78	2.84-6.06	<0.001
- 52 weeks	27.82				
%Muscle (n = 30)					
- Baseline	26.32	-1.91	1.61	-2.85 – (-0.98)	0.001
- 52 weeks	28.24				
ILM (229)					
Control (219)					
Body weight (kg) (n =97)					
- Baseline	64.48	-0.35	2.24	-0.8 – 0.104	0.129
- 52 weeks	64.83				
Waist (inch) (n = 97)					
- Baseline	34.01	-0.11	1.74	-0.46 – 0.24	0.541
- 52 weeks	34.11				
Body mass index (n = 97)					

- Baseline	25.13	-0.14	0.85	-0.31 - 0.032	0.11
- 52 weeks	25.27				
Visceral fat (n = 97)					
- Baseline	8.06	-0.33	0.88	-0.51 – (0.15)	<0.001
- 52 weeks	8.39				
%FAT (n = 97)					
- Baseline	30.52	-0.58	1.27	-0.84 – (0.32)	<0.001
- 52 weeks	31.1				
%Muscle (n = 97)					
- Baseline	25.91	-0.014	1.45	-0.31 - 0.28	0.922
- 52 weeks	25.93				
Behavioral Adherence					

Adherence rates were highest in the ILM + MR group, where 94% of participants consistently followed dietary and physical activity recommendations. The simplicity of meal replacements facilitated compliance with caloric restrictions. The ILM-only group achieved an 87% adherence rate, with slightly more variability in caloric and activity tracking [2,5].

The control group struggled with adherence, as evidenced by inconsistent reporting and a 22% attrition rate by week 52. Participants frequently cited a lack of structured support as a barrier to sustained behavior change [1,9].

Between-Group Comparisons

One-way ANOVA revealed statistically significant differences among the three groups at both 8 and 52 weeks for all primary outcomes. Post hoc pairwise comparisons showed that the ILM + MR group consistently outperformed the ILM-only group in weight loss, BMI reduction, and waist circumference improvement ($p < 0.05$). Both intervention groups demonstrated significantly better results than the control group across all metrics ($p < 0.001$) [1,6].

Table 5: Comparing outcome measurements between the intervention group and control group at follow-up periods at 52 weeks

Group	n	Mean	S.D.	p-value	Mean Difference	
					ILM	Control
Body weight (kg)						
ILM+MR	160	56.89	12.63	0.005	-6.25 (p = 0.019)	-7.94 (p = 0.004)
ILM	147	63.13	15.7		-	-1.7 (p = 0.663)
Control	97	64.83	15.28		-	-
Waist (inch)						
ILM+MR	154	28.97	2.53	<0.001	-3.6 (p < 0.001)	-5.14 (p < 0.001)
ILM	143	32.57	4.63		-	-1.54 (p = 0.029
Control	97	34.11	4.95		-	-
Body mass index (kg/m²)						
ILM+MR	160	21.97	3.85	<0.001	-2.42 (p = 0.006)	-3.31 (p < 0.001)
ILM	147	24.39	5.63		-	-0.89 (p = 0.382)
Control	97	25.27	5.01		-	-
Visceral fat						
ILM+MR	40	4.95	3.46	0.004	-2.47 (p=0.107)	-3.44 (p = 0.002)
ILM	38	7.42	5.63		-	-0.97 (p = 0.612)
Control	97	8.39	5.87		-	-
% FAT						
ILM+MR	36	25.43	6.34	<0.001	-2.58 (p=0.238)	-5.67 (p < 0.001)
ILM	30	28.01	6.43		-	-3.06 (p=0.058)
Control	97	31.1	6.43		-	-

%Muscle						
ILM+MR	37	21.17	2.97	0.035	-3.04 (p=0.928)	1.25 (p=0.136)
ILM	30	27.48	3.62		-	1.55 (p=0.036)
Control	97	25.93	3.41		-	-

* p = p-value

Attrition and Limitations

Attrition rates were lowest in the ILM + MR group (6%) compared to the ILM-only group (10%) and the control group (18%). Participants in the ILM + MR group cited greater satisfaction with the structured protocol and meal replacements, which simplified adherence to dietary goals. The ILM-only group faced challenges related to self-managed dietary changes, while the control group lacked sufficient motivation and accountability [2,10].

Discussion

This study highlights the significant impact of intensive lifestyle modification (ILM), particularly when combined with meal replacements (MR), on weight loss and body composition in obese individuals. Among the three groups, the ILM + MR group achieved the most substantial reductions in weight (-14.43 kg), BMI (-5.54), and waist circumference (-7.41 inches) over 52 weeks. These findings were statistically significant compared to both the ILM-only and control groups ($p < 0.001$). Furthermore, the ILM + MR group demonstrated notable improvements in body composition, with a 7.54% reduction in fat mass and a 2.33% increase in muscle mass. These results underscore the effectiveness of combining MR with ILM to achieve meaningful and sustainable changes in body composition and metabolic health [1,2].

The ILM-only group also showed considerable improvements, although the changes were less pronounced than in the ILM + MR group. Weight loss averaged 8.56 kg, accompanied by reductions in BMI (-3.25) and waist circumference (-4.25 inches). Fat mass decreased by 4.45%, and muscle mass increased by 1.91%, reflecting the benefits of structured lifestyle interventions even without MR. In contrast, the control group exhibited negligible progress, with slight increases in fat mass and waist circumference, and a reduction in muscle mass. These outcomes highlight the limited effectiveness of unstructured lifestyle advice in combating obesity and further emphasize the need for guided interventions [1,2].

The observed superiority of the ILM + MR intervention aligns with previous studies demonstrating the efficacy of MR in simplifying caloric control and enhancing dietary adherence. Davis et al. (2010) and other researchers have reported similar findings, showing that MR can enhance the effectiveness of lifestyle interventions by reducing decision fatigue and providing a convenient, controlled source of nutrition [7,5]. The preservation and even enhancement of muscle mass in the ILM + MR group are particularly notable, as muscle mass plays a critical role in metabolic health and long-term weight maintenance [5,3].

Sustainability of weight loss is a critical aspect of obesity management. At 52 weeks, both intervention groups maintained their improvements, with the ILM + MR group continuing to show the most substantial benefits. This long-term success can be attributed to the structured nature of the intervention, which included behavioral support, dietary guidance, and physical activity. Meal replacements also played a pivotal role in maintaining adherence by simplifying dietary requirements. These findings underscore the importance of comprehensive and sustained support in achieving long-term success in weight management [2,10].

From a public health perspective, the implications of this study are significant. The combination of ILM and MR represents a scalable and practical approach to addressing obesity, particularly in resource-limited settings. In countries like Thailand, where obesity prevalence is among the highest in Asia, integrating MR into ILM programs could provide a cost-effective solution to reduce the burden of obesity and its related comorbidities. Furthermore, the potential for cultural adaptation of MR formulations makes this approach highly versatile. Public health policies should focus on subsidizing meal replacements and expanding access to structured ILM programs to combat the obesity epidemic effectively [1,6].

The study's strengths include its robust sample size, which enhances the statistical power of the findings, and its longitudinal design, which allows for an evaluation of long-term outcomes. The inclusion of a control group provides a baseline for assessing the effectiveness of structured interventions. Additionally, the comprehensive approach to ILM, which incorporates dietary, physical, and behavioral components, addresses multiple facets of obesity, contributing to the intervention's success [2,9].

However, the study has several limitations. The retrospective design introduces potential biases related to data completeness and participant recall. While efforts were made to mitigate these limitations, a prospective randomized controlled trial would provide stronger evidence. Additionally, reliance on meal replacements may limit generalizability to populations where such products are unavailable or culturally inappropriate. Future research should explore culturally tailored MR options to enhance acceptance and adherence in diverse settings [1,5]. The study's geographic focus on Thailand may also limit the applicability of findings to other regions with different dietary patterns, healthcare systems, and socioeconomic factors.

Future research should build on these findings by conducting randomized controlled trials to validate the effectiveness of the ILM + MR intervention. Exploring the cost-effectiveness of such programs would provide valuable insights for policymakers, particularly in low- and middle-income countries. Additionally, investigating the impact of ILM + MR on quality of life, psychological well-being, and obesity-related comorbidities could further strengthen the evidence base for integrating these programs into public health strategies [10,3,12].

Conclusion

In conclusion, this study demonstrates the effectiveness of combining intensive lifestyle modification with meal replacements in achieving significant weight loss, improving body composition, and sustaining metabolic benefits over time [1,2,5]. The ILM + MR intervention offers a scalable and practical solution for addressing obesity, particularly in resource-constrained environments. By integrating these programs into public health initiatives, policymakers can make substantial progress in mitigating the global obesity epidemic and its associated health burdens [13-30].

Ethical Considerations

This study was reviewed and approved by The Ubon Ratchathani University Ethics Committee for Human Research. (approval number: UBU-REC-103/2567). The study followed ethical principles outlined in the Declaration of Helsinki. Confidentiality and anonymity of participant information were ensured throughout the study.

Authors' Contributions

NV led the study design and proposal development, conducted the research, analyzed and interpreted the data, and drafted the manuscript. SI supported study design and proposal preparation, and contributed to data collection and interpretation. RJ and SH contributed to study design and data collection. CS provided guidance on study conception and proposal development

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Competing interests

The authors declare no competing interests.

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