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The role of structured exercise and loving touch stimulation (SETS) with length for age z-score (LAZ) and Osteocalcin (OCN) levels among stunting children

El papel del ejercicio estructurado y la estimulación del tacto amoroso (SETS) en los niveles de puntuación Z de longitud para la edad (LAZ) y osteocalcina (OCN) entre niños aturdidos

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Abstract. Objectives: This study investigated the effects of structured training and loving touch stimulation (SETS) on improving L.A.Z. and OCN levels among stunting children aged six to eleven months old. Methods: This research uses a Pre-Experimental Design with a One-Group Pretest-Posttest Design Model. Stunting children aged 6 to 11 months, with good nutritional status and no history of chronic illness, were assigned randomly to SETS treatment (n=40) and Control group (n=40). The treatment group was given a routine care for stunting children program and SETS treatment. The control group received the same care without SETS treatment. LAZ and OCN levels were measured and collected at baseline and the end of week twelve. The data were analyzed using bivariate and multivariate analysis with linear regression to analyze independent variables and interference factors. Results: Subject characteristics, energy intake, history of infectious diseases, etc., were similar between intervention and control groups. Subjects treated with SETS provided higher LAZ and OCN than control subjects at approximately 1.45 and 11.5 ng/mL, respectively. SETS has a positive relationship with LAZ ($r = 0.865$, $P < 0.05$) and OCN ($r = 0.540$, $P < 0.05$). As a result of having higher levels of OCN of 18,25 ng/ml, which increases LAZ by 1,91, stunting children can benefit from SETS intervention. The SETS intervention in the treatment and control groups resulted in a 0.865-fold increase in the LAZ. Conclusion: OCN levels and fat intake positively correlate with the length for age z score increase ($p<0.05$), and the correlation is strong.
Keywords: Stunting, Psychosocial stimulation, Physical exercise, Bone formation

Resumen. Objetivos: Este estudio investigó los efectos del entrenamiento estructurado y la estimulación del tacto amoroso (SETS) en la mejora de L.A.Z. y niveles de OCN entre niños con retraso del crecimiento de seis a once meses de edad. Métodos: Esta investigación utiliza un Diseño Preexperimental con un Modelo de Diseño Pretest-Posttest de un solo grupo. Los niños con retraso del crecimiento de entre 6 y 11 meses, con buen estado nutricional y sin antecedentes de enfermedades crónicas, fueron asignados aleatoriamente al tratamiento SETS (n=40) y al grupo de control (n=40). El grupo de tratamiento recibió un programa de atención de rutina para niños con retraso del crecimiento y tratamiento SETS. El grupo de control recibió la misma atención sin tratamiento SETS. Los niveles de LAZ y OCN se midieron y recogieron al inicio y al final de la semana doce. Los datos se analizaron mediante análisis bivariado y multivariado con regresión lineal para analizar variables independientes y factores de interferencia. Resultados: Las características de los sujetos, la ingesta energética, los antecedentes de enfermedades infecciosas, etc., fueron similares entre los grupos de intervención y control. Los sujetos tratados con SETS presentaron niveles más altos de LAZ y OCN que los sujetos de control a aproximadamente 1,45 y 11,5 ng/ml, respectivamente. SETS tiene una relación positiva con LAZ ($r = 0,865$, $P <0,05$) y OCN ($r = 0,540$, $P <0,05$). Como resultado de tener niveles más altos de OCN de 18,25 ng/ml, lo que aumenta LAZ en 1,91, los niños con retraso del crecimiento pueden beneficiarse de la intervención SETS. La intervención SETS en los grupos de tratamiento y control resultó en un aumento de 0,865 veces en la LAZ. Conclusión: Los niveles de OCN y la ingesta de grasas se correlacionan positivamente con el aumento de la puntuación z de longitud para la edad ($p<0,05$), y la correlación es fuerte.
Palabras clave: Retraso del crecimiento, Estimulación psicosocial, Ejercicio físico, Formación ósea

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Introduction

Stunting is characterized by growth faltering with length for age z-score (LAZ) <-2 SD, which can be attributed to a deficiency in physical exercise, repeated infections, chronic malnourishment, and lack of psychosocial stimulation (Rakotomanana et al., 2023). During the first 1,000 days of life, stunting results in low immunity, disruption of metabolic processes, physical growth limitations, and cognitive function disruption (Nemerimana et al., 2023). Stunting is still high worldwide (Dibley et al., 2020). As a solution to the high number of stunting cases in the world, the WHO recommended pursuing stunted children's growth through integrating nutritional interventions, prevention of infection, psychosocial stimulation, and physical exercise (Aboud & Yousafzai, 2019; H.-I. Kim et al., 2012; Moon et al., 2023; Ruiz-juan & Zarauz, 2018).

The stunting rate in Indonesia is still very high, reaching 4.5 million children (Nadhiroh et al., 2024). The results of the Indonesian Nutritional Status Survey (SSGI) (2022) showed that the percentage of stunting has decreased from 24.4% (2021) to 21.6% (2022); however, the rate of stunting in Blora has increased by 4.4% from 21.4% to 25.8%. According to WHO recommendations, the government's stunting prevention efforts include specific and sensitive nutritional intervention programs. One of the stunting prevention programs in 2022 is to increase nutritional intake by giving one egg a day for stunted children (Banjara et al., 2024; Bierut et al., 2021). Other nutritional programs consisted of the administration of macro and micronutrients as well as a combination of 2-3 nutrients (Dewey et al., 2021; Soofi et al., 2022). Diversification of menus, dietary patterns, and supplementation could not prevent stunting and did not positively affect the increase in body length of stunting children under five years (Behailu et al., 2022; Komakech et al., 2022; Row, 2017).

The government also uses psychosocial stimulation therapy for stunting, including audio, visual, communication, tactile, kinesthetic, parenting class, and physical activity, including playing, training, and movement (Sisca et al., 2024). Tanoto Foundation protocol of psychosocial stimulation for stunting children aged 6 to 11 months involved parental education on physical stimulation such as playing, telling stories, and walking applied twice a day. Another program, psychosocial and physical exercise, approved by the Indonesian Health Ministry, is focused on the growth and development of healthy babies but is unspecified for stunting children (Baigaliev et al., 2024; S. Y. Kim et al., 2024).

Structured Exercise and Loving Touch Stimulation (SETS) combines tactile and kinesthetic stimulation using a baby gym and loving touch stimulation for stunting (Plancke, 2020; Simard & Consultant, 2016). Physical exercise by moving the joints and muscles mechanically stimulates the secretion of IGF-1. Touch stimulation provides stimulation of pressure receptors in the skin and muscle to promote the secretions of growth hormone (GH) and Insulin-like growth factor 1 (IGF-1). IGF-1 increases osteoblastic activity, which results in the production of OCN. OCN regulates bone-muscle metabolism and processes related to bone matrix maturity. Physical exercises and touch stimulation increased glucose metabolism and bone growth, including OCN levels. Exercise and touch stimulation given simultaneously on premature babies have a better positive effect on anthropometric measurement and increased IGF-1 level, bone-specific alkaline phosphatase (BSAP), and urinary osteocalcin (U-MidOc) (Behailu et al., 2022; Kohlmann et al., 2021; Toledo et al., 2023). Modified physical exercise and tactile stimulation effectively improve the growth and development of risk stunting (Kohlmann et al., 2021). SETS have been used to enhance the growth and development of risks of stunting babies and children; however, their evaluation does not involve markers and only looks at physical parameters. Therefore, this study highlighted the role of SETS in improving LAZ and OCN for stunting children aged 6-11 months.

Methods

The study's design was a Randomized Control Trial to see the efficacy of SETS in increasing LAZ and OCN levels of stunting children aged 6-11 months. The research was conducted at 43 stunting locus areas in 15 public health districts of Blora Regency (Central Java, Indonesia) from January to June 2023. The subjects' research was randomly divided into two groups. The treatment group received nutritional intervention according to the stunting program and SETS with frequency twice a day for 30 minutes each session, in the morning and afternoon after the bath for 12 weeks. The control group received a nutrition intervention from the baby stunting program and health education about caring for stunted children. All groups were monitored and measured for LAZ and OCN levels before and after treatment (Bierut et al., 2021; Suyatno et al., 2022).

Participants

The research target population was obtained from preliminary E-PPBM (Community-Based Nutrition Recording and Reporting) survey data in January 2023, which stated that of 16,958 children under two years old, 885 were indicated to be stunted. There were 80 children aged under two years who indicated stunting and met the inclusion and exclusion criteria as a sample study. The inclusion criteria include age 6-11 months, LAZ <-2SD to -3SD as the WHO Child Growth Standards Median, good nutritional status, and primary immunization according to the age during the study period. The exclusion criteria include physical defects, congenital disability, chronic illness, and suffering from severe infectious diseases and skin diseases such as eczema. Subjects who did not undergo the treatment of SETS for three consecutive days would be dropped out. This is by the Do category, and according to the SETS protocol, it is carried out twice daily. If this protocol is violated for three consecutive days, the results of stunting treatment will be affected. Furthermore, the subjects were explained various matters relating to the research in writing and orally, and informed consent was signed as proof of their willingness to follow this research procedure. There were 80 subjects in this study randomly divided into two groups: the intervention group (40) and the control group (40).

The determination of the intervention or control group was based on the area of the public health center, where all subjects in one public health center were made into intervention groups at once or control groups to avoid bias of treatment between respondents within one public health center. The number of respondents who followed the study until completion of the study was 77, which was 39 respondents in intervention and 38 respondents in treatment groups. Respondents who did not complete the study were dropped out because they were unwilling to take blood for examination, moved to another area without notice, and were inaccessible to the researchers. The process of taking the research subjects was summarized in the consort diagram in Figure 1.

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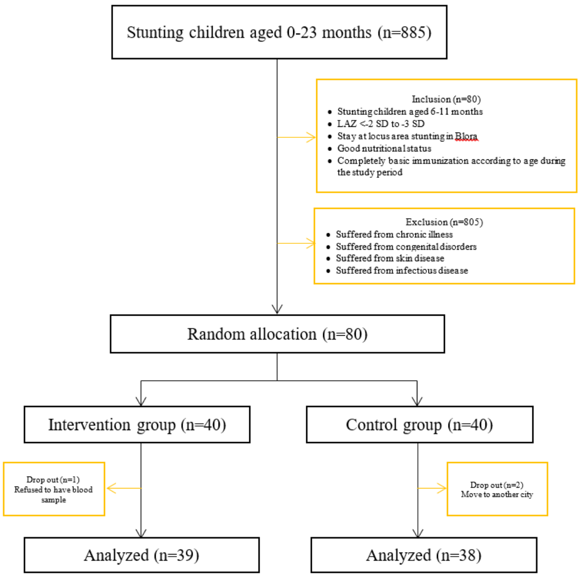

Figure 1. Consort diagram for selecting research subjects

Research procedures

The research started with selecting and training enumerators consisting of 15 nutritionists and 15 laboratory experts from public health centers, 43 village midwives, and 47 cadres accompanying stunting families. Selection of cadres enumerators based on the region and the number of respondents: each enumerator was responsible for 1-2 respondents residing in the areas close to the respondent's location. The selected enumerators were trained on instruments, how to measure data, and how to retrieve treatment respondents. Training cadres enumerators was carried out in several stages: training on data retrieval instruments and how to treat the respondents. A total of 30 enumerators in the intervention group were also trained on SETS intervention conducted by the researcher as Certified Infant Massage Instructor International and Trainer of Training Baby Gym and Baby Massage from the Health Department. The training using a curriculum of training accredited by the Health Department includes theory, demonstration, and evaluation.

Measuring and Monitoring

As part of the data collection stage, anthropometric measurements and serum samples are taken before and after the intervention. The data were measured at the beginning of the first week and the end of the twelfth week. Data was collected in the Public Health Centre because of standardization based on the measurement site, anthropometric kit, blood sampling procedures, and serum storage. The measurements were conducted anonymously between the nutritionist and the laboratory. Blood samples were obtained at baseline and the end of the study from stunting children aged 6 to 11 months. Samples were centrifuged and plasma removed within 2 hours of blood collection; aliquots were stored in -80^{0}C freezers until shipped on dry ice for analysis. Serum samples were tested for osteocalcin (OCN) biomarkers and measured by an ELISA method from R&D Systems (Minneapolis, MN, USA) (Momo Kadia et al., 2024).

The baseline characteristics of the respondents, including weight, length, age, sex, history of immunization, nutritional status, and health status, were recorded. At the end of the twelfth week, measurements of LAZ and OCN were taken to obtain post-intervention data. To control the presence of additional factors that could affect the study's findings, food recall assessments conducted three times a day were used to track the amount of food consumed during the research process. Other accompanying diseases were also considered, as was the application of interventions based on information from the research activities checklist and records. LAZ monitoring was also done every month.

Intervention

The SETS intervention is part of a kinaesthetic tactile stimulation for stunting children in a combination of the gym for stunting kids and kid's massage performed by cadres enumerators given twice a day in the morning and afternoon after shower for 12 weeks. Each session consisted of 20 minutes divided into three minutes of preparation, 15 minutes of SETS session, and two minutes of termination. A SETS was started from the front of the body so that the baby was laid down in a supine position. Firstly, the legs were massaged, including Indian massage, sweeping top foot, Swedish massage, kinaesthetic stimulation (knees-up), massage at stomach area: water wheels, chest: chest loving touch, arms and hands: lymphatic exercise, Indian Massage, elbow flexion-extension. The face area included cheekbone massage, mouth circle, smile upper and bottom lip, and lips and chin circle stimulation. For back massage, the baby was laid in the prone position; the strokes started from the head area, with a head-loving touch, shoulder, back-loving contact, arm-loving connection, and feet-loving communication. A series of SETS was carried out six times for each stroke. The cadre's enumerators recorded and reported their intervention using WhatsApp groups through photos and video activities. The enumerator cadres must ensure that the gym and massage activities in the field in the SETS series are carried out correctly and professionally, one of which is by documenting them through photos and videos. Photos and videos of the series of SETS activities were then uploaded to the WhatsApp group for discussion and analysis by the research team and all enumerator cadres to verify the process and validate the results of the SETS activities that had been carried out.

Statistical Analysis

The independent variable in this study is the SETS intervention. Interfering factors in essential characteristics and nutritional status were controlled by providing additional food according to government programs and adding one egg per day so that all groups were expected to be homogeneous. This is because the age of 6-11 months is the age of 1000 hp for cath-up growth; this age has almost the same characteristics, especially in feeding.

Data were subjected to statistical evaluation, including descriptive statistics for subject characteristics, Wilcoxon Signed Rank on the differences of the length for aged z-scores, paired t-test in the assessment of serum osteocalcin levels before and after being given SETS in the intervention group, and correlation and linear regression tests for SETS with LAZ and OCN. All statistical evaluations were carried out using SPSS version 23.0.

Ethical Clearance

This research was approved by the Health Research Ethics Committee, Medical Faculty, Diponegoro University Semarang No.450/EC/KEPK/FK-UNDIP/XII/2022.

Results

The characteristics of the research subjects in the intervention and control groups were homogeneous regarding gender, age, carbohydrate intake, calcium intake, vitamin A, sleep quality, parenting patterns, and osteocalcin levels. Statistical tests showed that there was no significant difference (p>0.05) for sex, age, carbohydrate intake, calcium, vitamin A, infection disease, sleeping quality, parenting, and OCN and statistically different (P<0.05) for LAZ, intake of energy, protein, fat, vitamin D and Zinc. Table 1 compiled the characteristics of the subjects'

Table 1.
The subject's characteristics of the study (n=77)

Subject Characteristics	Intervention Group	Control Group	*p*
Sex, n (%)			
Male	24 (61,5)	24 (63,2)	0,883[a]
Female	15 (38,5)	14 (36,8)	
Age, month, mean ± SD	8 ± 1,71	8 ±1,29	0,767[b]
LAZ, median ± SD			
January	- 2,3 ± 0,29	-2,44 ± 0,16	0,004[c]
February	- 1,72 ± 0,51	-2,33 ± 0,16	<0,001[c]
March	- 1,19 ± 0,43	-2,26 ± 0,15	<0,001[c]
April	- 0,99 ± 0,47	-2,15 ± 0,13	<0,001[c]
May	- 0,39 ± 0,53	-2,03 ± 0,11	<0,001[c]
Osteocalsin, median ± SD			
Pre - Intervention	92 ± 26,3	92,13 ± 28,31	0,983[b]
Energy			
Kkal, median ± SD	646,7 ± 63,26	567,6 ±111,11	0,010[c]
Intake Percentage Median ± SD	81 ± 6,17	71 ± 13,85	0,011[c]
Energy Deficit n (%)			
Heavy	5 (12,8)	18 (47,4)	<0,001[d]
Moderate	13 (33,4)	9 (23,7)	
Light	21 (53,8)	5 (13,1)	
Normal	0	6 (15,8)	
Carbohydrate			
Median Number of Gram ± SD	44,8 ± 9,74	42,8 ± 7,72	0,827[c]
Intake (%) median ± SD	43 ±9,26	41 ± 7,39	0,748[c]
Category n (%)			
Less	32 (82,1)	34 (89,5)	0,352[a]
Normal	7 (17,9)	4 (10,5)	
Protein			
The mean number of grams ± SD	8.95 ± 1.88	6,52 ± 1.65	<0.001[b]
Intake (%) mean ± SD	59.69 ± 12.54	43.42 ± 10.99	<0.001[b]
Category, n (%)			
Heavy	30 (76.9)	38 (100)	0.001[a]
Moderate	6 (15.4)	0	
Normal	3 (7.7)		
Fat			
The mean number of grams ± SD	4.95 ± 1.60	7.04 ± 0,99	<0,001[b]
Intake (%) mean ± SD	14.15 ± 459	20,13 ± 2,89	<0,001[b]
Category, n (%)			
Less	34 (87,2)	15 (39,5)	<0,001[a]
Normal	5 (12,8)	23 (60,5))	
Vitamin A, n (%)			
No	20 (58,8)	14 (41,2)	0,202[a]
Yes	19 (44,2)	24 (55,8)	
Vitamin D, n (%)			
No	38 (97,4)	31 (81.6)	0,029[d]
Yes	1 (2,6)	7 (18,4)	
Calcium, n (%)			
No	36 (92,3)	36 (94,7)	1,00[d]
Yes	3 (7,7)	2 (5,3)	
Zinc, n (%)			
No	28 (71,8)	36 (94,7)	0,007[a]
Yes	11 (26,2)	2 (5,3)	
Infection Disease n (%)			
No	36 (92,3)	38 (100)	0,219[a]
Yes	3 (7,7)	0	
Sleeping Category, n (%)			
Bad	2 (5,1)	3 (7,9)	0,563[a]
Moderate	20 (51,3)	15 (39,5)	
Good	17 (43,6)	20 (52,6)	
Parenting score, Mean ± SD	36,21 ± 7,81	37 ± 7,16	0,643[b]
Category, n (%)			
Less	28 (71,8)	12 (31,6)	0,746[a]
Good	11 (28,2)	26 (68,4)	

p[a] Chi-Square, p[b] Independent T-test, p[c] Mann Whitney, p[d] Fisher Exact

Table 2.
Differences in LAZ and Osteocalcin values in stunting children aged 6-11 months before and after given SETS intervention

Variable	Pre-test	Post-test	Mean Differences	p
Z-Length for Age (LAZ)				
Intervention	-2,3 ± 0,29	-0,39 ± 0,53	1,91	<0,001[a]
Control	-2,44 ± 0,16	-2,03 ± 0,11	0,41	<0,001
Osteocalcin (ng/ml)				
Intervention	92 ± 26,30	110,26 ± 25,23	18,25	<0,001[b]
Control	92,13 ± 28,31	92,45 ± 89	0,315	0,878[b]

Data are presented as Mean ± SD, p[a] Wilcoxon Signed Rank test, p[b] Paired T-test.

Table 3.
Changes in the values of the study variables LAZ and Osteocalcin

Δ	Intervention group (n=39)	Control group (n= 38)	*p*
Length for Age Z- Score	-1,76 ± 0,60	-0,38 ± 0,16	<0,001
Osteocalcin	-14 ± 13,7	- 2,5 ± 12,6	<0,001

Median data ± SD, p Mann Whitney.

Table 2 presented that the LAZ and OCN increased significantly by 1.91 and 18.25 ng/ml (p<0,05) after receiving SETS treatment. These results demonstrated that the increase in LAZ and OCN in the intervention group was higher than in the control group. Table 3 revealed the changes in variable values of LAZ and OCN. The mean differential delta values of LAZ and OCN in the intervention group were 1.42 and 11.5ng/ml (p<0.05), respectively.

Table 4 demonstrated that giving SETS treatment revealed a robust correlation with the positive direction towards length for age z-score. SETS intervention could increase the LAZ of stunting children aged 6-11 months by 86.5%. This implies that the more frequently given SETS treatment, the higher the LAZ addition in stunting children aged 6-11 months. There is a reasonably strong correlation with a positive direction between osteocalcin levels and fat intake towards length for age z score increase (p<0,05).

Table 4.
The result of the correlation test of osteocalcin and all factors with Length for Age Z-Score in intervention and control group. (n=77)

Variable	Length for Age Z- Score			
	Intervention Group (n=39)		Control Group (n= 38)	
	r	*p*	r	*p*
Delta_Osteocalsin	0,021	0,900	0,047	0,780
Vitamin A	0,556	<0,001*	-0,376*	0,020*
Intake Energy	0,048	0,773	-0,213	0,199
Intake Carbohydrate	0,167	0,309	-0,140	0,402
Intake Protein	0,321	0,047*	-0,049	0,770
Intake Fat	-0,089	0,590	-0,454	0,004*
Intake Calcium	-0,359*	0,025*	-0,145	0,384
Sleeping pattern	-0,076	0,644	-0,073	0,665
Parenting	0,091	0,583	-0,134	0,421
Infection Disease	0,004	0,979		

*p Spearman Rho

Discussion

Stunting is when a child's body length growth is delayed or impaired due to chronic nutritional deficiency, recurrent inactivity, and lack of psychosocial stimulation and physical exercise (Fazid et al., 2024). Stunting is usually measured by length for age z - scores <-2SD. Stunting in the first 1,000 days of life leads to a physical growth barrier, a linear growth disorder affecting bone growth. Stunted children are more likely to have bone growth disorders due to hormonal imbalances, unbalanced nutritional intake, recurrent infections, lack of psychosocial stimulation, and physical inactivity (Suyatno et al., 2022).

The production of Growth Hormone (GH) is influenced by the interplay of factors that cause stunting at the cellular level. GH causes the liver to produce Insulin-Like Growth Factor-1 (IGF-1) to promote the processes involved in bone growth. The activity of the osteoblasts that produce osteocalcin (OCN) affects bone growth. OCN regulates bone growth, bone matrix maturity, and the metabolism of bones and muscles. OCN levels are more frequently detected during childhood growth, and appropriate stimulation and physical activity impact elevated OCN levels in serum (Gancheva et al., 2020; Lima et al., 2023; Susanto et al., 2020).

Enhancing bone growth can be achieved with physical exercise combining movement and massage stimulation. By mechanically stimulating GH activity and IGF-1 secretion, physical training of the upper and lower limbs promotes bone growth metabolism and increased OCN parameters, a marker of bone formation. Furthermore, touch stimulation with massage activates a vague system that affects intestinal motility and insulin secretion, helping to improve food absorption; it also stimulates neurotransmitter activity that promotes increased serotonin and dopamine levels and suppresses cortisol secretion. This parasympathetic response is brought on by stimulating pressure receptors in the skin and muscle, which stimulates the secretion of GH and IGF-1 (Dradjat et al., 2021). Additionally, touch stimulation improved psychological well-being.

The results of this study confirmed that when structured exercise and loving touch stimulation (SETS) interventions were given to stunting children aged 6 to 11 months, twice a day, six days a week, for twelve weeks, LAZ and OCN increased by roughly 1.91 and 18.25, respectively. The results of this study are consistent with earlier research demonstrating that, in infants under the age of four weeks, physical activity with passive motion exercises performed once a day for 15–30 minutes each time for four weeks increased body length by 1.7–2.24 cm and improved bone mineralization and bone strength as measured by dual-energy x-ray absorptiometry (DEXA) and quantitative ultrasound (QUS). Interventions carried out daily for the same duration and frequency until the eighth week were also demonstrated to significantly increase the body's length (Canday et al., 2024).

The Erdem et al. (2015) study reported that massage stimulation to newborns once daily for 15-20 minutes led to a length increase of 2,51 ±0,19 cm and three to four times higher IGF-1 levels in the treatment group. In premature babies stimulated by premature massage, IGF-1 rates also increased significantly (Erdem et al., 2015). Subsequent research has demonstrated that touch stimulation combined with physical exercise has better positive effects on anthropometric measurements, as well as increased levels of IGF-1, bone-specific alkaline phosphatase (BSAP), and alkaline phosphatase (AP) as well as a 32% increase in U-MidOc.

The combination of structured exercise and loving touch stimulation interventions, known as SETS, has been found to positively affect body length increase (p<0.05) and vitamin A, protein, and calcium intake in stunted children. Consistent with previous studies, tactile kinesthetics combined with baby gym exercises can significantly increase the body length in babies at risk of stunting (p<0,05) (Sutarmi et al., 2022). Harmonized outcomes were also observed in a locus stunting study conducted in the Indonesian region with older participants, ages 6 to 24 months, using a combination of exercise movement and massage in conjunction with the well-known "sasak" culture called OBISA. The result increased Body length by 4.73 cm after receiving an OBISA massage; however, this study needs to adjust for dietary intake (Sutarmi et al., 2022).

SETS intervention was associated with an elevated level of OCN. Serum levels increased by 18.25 ng/ml or 11.5 ng/mL, a statistically significant increase with the intervention P < 0,05. The variations in osteocalcin levels observed in this study corresponded to the 10–80 ng/ml range of normal limits for osteocalcin levels in children aged 6–11 months. The OCN is an essential biochemical marker in bone mineralization processes, particularly in bone formation (Wang et al., 2021). This is consistent with a previous report by Chen H. et al. (2028), who stated that assisted exercise in premature babies twice daily for five weeks effectively improved bone strength, as shown by increased bone metabolism and osteocalcin. Furthermore, physical exercise given gradually from mild to moderate in pre-adolescent children diagnosed with DM type 2 demonstrated that OCN is positively associated with even unstructured physical activity (Sari & Herawati, 2020).

Although LAZ is a specific parameter for stunting children and OCN is a sensitive and specific marker of osteoblastic marker for bone formation, it is not enough to predict bone growth. Other parameters are needed for bone resorption. Due to the study's limitations, which only examine the small effect of SETS interventions on the rise in LAZs and OCNs, additional research is desperately required to determine whether interventions alone are responsible for the increase in LAZs and OCNs. Future research is also advised to examine the process of bone resorption and its biomarkers because increases in body length are linear with increases in bone growth.

Conclusion

Stunting is growth faltered because of lack of nutrition, repeated infection, and lack of psychosocial stimulation and physical exercise. SETS is a model that involves psychosocial stimulation and physical exercise with baby gym and loving touch stimulation. SETS that were administered twice daily for three months effectively improved the length of the body by speeding up the process of bone formation. Stunting children aged 6 to 11 months can benefit from SET intervention by improving by 0.865 times. This suggests that the more frequently SETS treatment is administered, the higher the length for age z-score is increased. OCN levels and fat intake positively correlate with length for age z score increase ($p<0.05$). This correlation is strong.

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