Research Note

Energy Rich Snacks May be Preferable to Lunch with High Lipid to Increase Energy Intakes in Older Adults at Risk of Malnutrition, Northern Thailand

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ABSTRACT *Background:* Our previous studies have shown that undernourished older adults in Northern Thailand had low lipid intake, resulting in energy deficiency. To increase energy intake, perhaps we could suggest two methods, one is to increase lipid in lunch and the other is an energy rich snack. *Aims:* To investigate effects of lunch with high lipid or an energy rich snack on energy intakes in older adults at risk of malnutrition. *Method:* Participants were 8 elderly people (average age 70.8±4.1 years) with risk of malnutrition (body mass index 17.8±2.0 kg/m^2). A randomized cross-over design was used to compare dietary intake under two diets: control (regular diet) and intervention (energy enhanced with lipids in meal and snack) on three days. Washout period was two days. In this study, energy was enhanced only for lunch and snack, but not breakfast and dinner. Energy for lunch was increased with rice bran oil. Energy in the snack was increased with coconut milk/peanuts and a box of soy milk. A 24-hour dietary survey using the recall method was conducted for the 3 days before, and during each of the two periods. *Results:* Although the energy supply at lunch in the intervention period was increased to about 700 kcal from about 600 kcal in the control period, the intake was similar between the two periods, being about 450 kcal, suggesting that the subjects could not eat increased lipids, maybe because of the large portion size. Average energy intakes from energy-rich snacks increased by about 2.5 times of the control (from 122±34 to 313±48 kcal, *P*=0.012), maybe because the portion size was small, resulting in about a 200 kcal increase per day (from 1,312±153 to 1,511±190 kcal, *P*=0.012). *Conclusion:* From the present study, we found that in older adults at risk of malnutrition, increasing energy from snacks is more acceptable than lunch with high lipid.
Key words: energy intakes, snacks, meals, older adults, risk of malnutrition

INTRODUCTION

Inadequate energy and protein intakes are frequently reported in the elderly (1), thereby increasing the risk of malnutrition. The Thai National Health Examination 2014 reported the prevalence of malnutrition in older aged 60 - 69 years as approximately 10% in males and 4% in females and this increased at advanced ages (2).

Our previous study (3) that showed older adults dwelling in community settings in northern Thailand had inadequate energy consumption, with estimated daily energy and lipid intakes accounting for 92% and 40% of the Thai recommended dietary allowances (RDA).The prevalence of underweight as determined by body mass index (BMI) < 18.5 kg/m^2 was reported as 18% in males and 9% in females, which was two times as high as underweight in the survey of the Thai National Health Examination.

This study was conducted before the main study. The first reason was that we did not know whether our undernourished participants could consume higher lipid than their current intake. We tried to find from various studies what kind of lipids are better accepted by malnourished elderly. In some papers the advantages of oleic acid were reported. Oleic acid has a lower satiating effect than other fatty acids such as saturated and long-chain polyunsaturated fatty acids (4). We looked for oleic acid-rich foods common in Northern Thailand and found that they are peanut oil (45-53%) (5) and rice bran oil (43.9%) (6). Therefore, in the present study, for the intervention lunch, we used rice bran oil. Soybean oil was used in the control diet because it is the most common oil.

In our previous study, we observed that the frequency and the energy of snacks were low. Therefore, in this study we tried to increase the energy from snacks by adding ground peanuts that contain high oleic acid and also used coconut milk, which is rich in energy and tasty. In addition, soy milk was offered as a substitute for milk by people who are lactose intolerant as well as low cost and nutritious.

It is important to explore the effective strategies to promote adequate dietary intake in community dwelling elderly. This will be helpful in preventing or slowing progression of chronic diseases and diminish hospitalization. The Objective of this study was to investigate effects of lunch with high lipid and energy rich snack on energy intakes in older adults at risk of malnutrition.

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METHODS

Study design and participants

This study was a randomized, controlled, cross-over design to evaluate dietary intakes under two diets: control (regular diet); intervention (energy enhanced) at lunch and snack for three days. Washout period was two days. The potential participants were screened from medical records of Ban Ton Keaw District Health Promotion Hospital in November to December 2020. Those willing to participate were informed about the study and screened for inclusion criteria were aged 65 – 79 years old, body mass index less than 20 kg/m^2 and/or recent unintentional weight loss, able to eat by mouth, not having any illness that may affect taste or appetite such as cancer, chronic kidney disease and having no dementia or depression.

After screening, 8 participants (6 females and 2 males) were included in the study and they provided informed consent.

Control and Intervention diet

Daily lunch and snack were delivered to the participants' homes. Lunch consisted of glutinous rice, a main dish (meat/fish), boiled vegetable and soup with meat/fish and vegetable.

In the intervention lunch, rice bran oil was used, and soy bean oil was used in the control diet, general ingredients and seasoning were kept the same in both diets. The composition, energy and macronutrient content of the lunch and snack in the control and intervention diets are shown in Table 1. Energy, protein, lipid and carbohydrate in the intervention and control lunches were 660 - 699 and 580 - 598 kcal, 29 - 43 and 28 - 43 g, 24 - 34 and 10 - 19 g, 69 - 76 and 68 - 75 g, respectively.

The snack consisted of pandan jelly, sweet pumpkin, and glutinous rice with perilla seed. In the intervention snack, coconut milk/ground peanuts were added, and a box of soy milk (250 ml) was offered. Energy, protein, lipid and carbohydrate in the intervention and control snacks were 267 - 471 and 44 - 222 kcal, 7 - 11 g and 0 - 3 g, 11 - 21 g and 1- 10 g and 7 - 34 g, respectively.

A five-point facial hedonic scale was used to evaluate acceptability test (appearance, aroma, texture, taste and overall) of foods.

Anthropometric measurements

Body weight and body composition were assessed about 2 hours or more after breakfast, using bioelectrical impedance analysis (Model HBF214, Omron, Japan). Height was measured using a portable, free-standing stadiometer. Triceps skinfold (TSF) was measured by using a Fat-O-caliper (Takei Kikai Kogyo Co., Ltd.). Hand grip strength was measured by a digital handgrip dynamometer (Camry, South El Monte, CA, USA). All the measurements above were assessed before the study.

Dietary survey

A 24-hour recall method dietary survey was conducted 3 days before the study and in each of the two periods. However, to ensure that the participants provided complete data, they were also requested to keep an estimated record of all foods and beverages consumed in the dietary record form. In addition, all participants were instructed to place all food leftovers and containers in a labeled plastic bag and to show them to the researchers to determine intakes. All data were entered and calculated for energy and nutrient intakes (protein, lipids, carbohydrate, saturated fatty acid, cholesterol and dietary fiber) using the INMUCAL-Nutrient version 4.0 (Institute of Nutrition, Mahidol University, Thailand).

Ethical Considerations

This study was done in accordance with the Helsinki Declaration and was approved by the Committee of Research Ethics in the Faculty of Public Health, Chiang Mai University, Thailand. Project number ET019/2020.

Statistical Analysis

Descriptive statistics such as mean, standard deviation and percentage were used to quantify the characteristics of the participants and dietary intakes. Data were analyzed using SPSS version 22. Results from the two diets' differences were confirmed using Wilcoxon signed ranks tests. All tests were two-tailed and a *P*-value of 0.05 was considered as statistically significant.

RESULTS

Participants

The participants were six females (75%), two males (25%), who had an average age of 70.8 ± 4.1 years, body mass index 17.8 ± 2.0 kg/m^2, body fat 24.8 ± 8.1%, muscle mass 28. 1 ± 1. 4%, calf circumference 21. 9 ± 3. 3 cm, mid upper arm circumference 22.6 ± 3.0 cm, triceps skin fold 16.3± 3.7 mm, hand grip strength 18.9 ± 3.0 kg (Table 2).

Table 2. Baseline characteristics of the 8 participants.

Characteristics	Mean ± SD
Gender (number male/female)	2/6
Body mass index (kg/m^2)	17.8±2.0
Body fat (%)	24.8±8.1
Muscle mass (%)	28.1±1.4
Calf circumference (cm)	21.9±3.3
Mid upper arm circumference (cm)	22.6±3.0
Triceps skin fold (mm)	16.3±3.7
Hand grip strength (kg)	18.9±3.0

The acceptability of control and intervention diet

The acceptability scores of appearance, aroma, texture, taste and overall of both diets were found to be similar (control diet: 4.1 ± 0.2; 4.2 ± 0.1; 4.3 ± 0.2; 4.3 ± 0.2 and 4.3 ± 0.2, intervention diet: 4.2 ± 0.1; 4.2 ± 0.2; 4.4 ± 0.1; 4.3 ± 0.2 and 4.3 ± 0.2, respectively, as shown in Table 3. No difference in acceptability scores between either control diet compared with the intervention diet were identified.

Dietary survey

Although the energy supply at lunch in the intervention period was increased to about 700 kcal from about 600 kcal in the control period, the intake was similar between the two periods, being about 450 kcal, suggesting that the subjects could not eat increased lipids, maybe because the portion size was quite large. Average energy intakes from snack increased about 2.5 times (191 kcal) the control (from 122 ± 34 to 313 ± 48 kcal, $P = 0.012$), maybe because the portion size was small enough for stomach volume.

Table 1. Food composition, energy, and major nutrients content of the three-day lunches and snacks during control and intervention periods.

Control period	Composition	E kcal	P g(%)	F g(%)	C g(%)	Intervention period	Composition	E kcal	P g(%)	F g(%)	C g(%)
Day 1	**Total lunch + snack**	**643**	**31 (20%)**	**21 (29%)**	**82 (51%)**	**Day 1**	**Total lunch + snack**	**958**	**44 (18%)**	**38 (36%)**	**111 (46%)**
	**Lunch** :wax gourd soup with chicken	210	13	13	11		**Lunch:**w ax gourd soup with chicken	245	13	16	11
	Chili paste with ground pork, tomato	127	13	6	6		Chili paste with ground pork, tomato, egg	185	18	10	6
	Boiled vegetables	26	1	0	5		Boiled vegetables	26	1	0	5
	Glutinous rice	235	5	0	54		Glutinous rice	235	5	0	54
	Total lunch	**598**	**31**	**19**	**75**		**Total lunch**	**691**	**37**	**26**	**76**
	Snack: Pandan jelly	**44**	**0**	**2**	**7**		**Snack:** Pandan jelly, soymilk	**267**	**7**	**11**	**35**
Day 2	**Total lunch + snack**	**802**	**30 (15%)**	**32 (36%)**	**99 (49%)**	**Day 2**	**Total lunch + snack**	**1,170**	**37 (13%)**	**55 (42%)**	**131 (45%)**
	**Lunch:** cabbage soup	224	14	16	6		**Lunch:** cabbage soup	303	14	24	6
	Chili paste	20	1	0	4		Chili paste	60	1	4	4
	Boiled vegetables	26	1	0	5		Boiled vegetables	26	1	0	5
	Boiled egg	76	7	5	1		Boiled egg	76	7	5	1
	Glutinous rice	235	5	0	54		Glutinous rice	235	5	0	54
	Total lunch	**580**	**28**	**22**	**68**		**Total lunch**	**699**	**29**	**34**	**70**
	Snack: Sweet pumpkin	**222**	**2**	**10**	**31**		**Snack:** Sweet pumpkin topping with coconut milk, soymilk	**471**	**8**	**21**	**62**
Day 3	**Total lunch + snack**	**739**	**46 (25%)**	**16 (20%)**	**102 (55%)**	**Day 3**	**Total lunch + snack**	**1,059**	**55 (20%)**	**36 (31%)**	**129 (49%)**
	**Lunch:**m ixed vegetable soup, chicken	220	12	13	13		**Lunch** :mixed vegetable soup, chicken	279	12	20	13
	Spicy soup with fish	126	26	2	2		Spicy soup with fish	146	26	4	2
	Glutinous rice	235	5	0	54		Glutinous rice	235	5	0	54
	Total lunch	**581**	**43**	**15**	**68**		**Total lunch**	**660**	**43**	**24**	**69**
	Snack: Glutinous rice, perilla seed	**158**	**3**	**1**	**34**		**Snack:** Glutinous rice, perilla seed, soymilk	**399**	**11**	**13**	**60**

E = energy; P = protein; F =f at; C = carbohydrate

In addition, lipid, protein, carbohydrate, saturated fatty acid, cholesterol and dietary fiber intakes were increased from 3.9 ± 0.9 to 13.0 ± 1.7 g, 1.4 ± 0.5 to 7.0 ± 1.0 g, 20.2 ± 6.0 to 41.9 ± 7.2 g, 3.1 ± 0.7 to 4.9 ± 1.0 g, 0.0 ± 0.0 to 6.1 ± 1.5 g and 0.9 ± 0.2 to 1.2 ± 0.3 g, respectively, as shown in Table 4. This resulted in an increase of about 200 kcal a day from 1,312 ± 153 to 1,511 ± 190 kcal, $P = 0.012$, as shown in Table 5.

The energy and major nutrient intakes from lunch were much lower than the supply. On the other hand, the energy and major nutrient intakes from the snack were more similar to the supply, as shown in Figures 1 and 2.

Table 3. Comparison the acceptability test between control and intervention diet

Menus	Diet	Appearance	Aroma	Texture	Taste	Overall
Chili paste, ground pork with tomato	Control	4.1±0.6	4.3±0.7	4.4±0.5	4.3±0.7	4.5±0.5
	Intervention	4.3±0.7	4.3±0.7	4.4±0.5	4.4±0.7	4.5±0.5
Wax gourd soup with chicken	Control	4.0±0.5	4.4±0.5	4.3±0.5	4.4±0.7	4.3±0.5
	Intervention	4.3±1.0	4.0±0.6	4.4±0.8	4.0±0.8	4.0±1.7
Cabbage soup with pork	Control	4.1±0.6	4.3±0.7	4.4±0.7	4.4±0.7	4.4±0.5
	Intervention	4.4±0.5	4.3±0.7	4.4±0.5	4.6±0.7	4.4±0.5
Chili paste with dried fish	Control	4.4±0.9	4.1±0.8	4.4±0.7	4.8±0.5	4.8±0.5
	Intervention	4.3±0.7	4.3±0.5	4.3±0.7	4.3±0.9	4.4±0.7
Spicy soup with fish	Control	3.9±0.4	4.0±0.0	4.4±0.5	4.1±0.4	4.4±0.5
	Intervention	4.1±0.6	4.4±0.5	4.4±0.5	4.5±0.5	4.3±0.5
Mixed vegetable soup with chicken	Control	3.9±0.4	4.3±0.7	4.3±0.5	4.4±0.5	4.0±0.0
	Intervention	4.1±0.4	4.0±0.8	4.3±0.5	4.4±0.5	4.1±0.4
Pandan jelly	Control	4.3±0.9	4.1±0.6	4.8±0.5	4.4±0.5	4.4±0.5
	Intervention	4.1±0.4	4.5±0.8	4.4±0.5	4.4±0.5	4.3±0.5
Sweet pumpkin	Control	4.1±0.8	4.0±0.8	4.4±0.7	4.4±0.7	4.4±0.7
	Intervention	4.3±0.7	4.1±0.8	4.4±0.5	4.1±0.8	4.1±0.6
Glutinous rice with perilla seed	Control	4.1±0.8	4.4±0.7	3.9±0.8	4.0±0.5	4.1±0.6
	Intervention	4.3±0.7	4.4±0.7	4.4±0.5	4.1±0.6	4.4±0.7
Average	Control	4.1±0.2	4.2±0.1	4.3±0.2	4.3±0.2	4.3±0.2
	Intervention	4.2±0.1	4.2±0.2	4.4±0.1	4.3±0.2	4.3±0.2

Data are shown in mean ± SD. There were no statistically difference between control and intervention diets in each dish by Wilcoxon's signed rank test at $P < 0.05$.

Table 4. Comparison of energy and nutrient intakes during control and intervention periods at lunch and snack

	Lunch		*P value*	Snack		*P value*
	Control	Intervention		Control	Intervention	
Energy (kcal)	449±67	454±137	1.000	122±34	313±48	0.012*
Lipid (g)	11.2±2.4	14.5±4.6	0.161	3.9±0.9	13.0±1.7	0.012*
Protein (g)	22.5±3.2	20.8±7.0	0.674	1.4±0.5	7.0±1.0	0.012*
Carbohydrate(g)	64.6±11.1	60.0±19.1	0.484	20.2±6.0	41.9±7.2	0.012*
Saturated fat (g)	3.2±0.8	3.8±1.3	0.327	3.1±0.7	4.9±1.0	0.012*
Cholesterol (mg)	100.8±25.7	131.7±33.3	0.036*	0.0±0.0	6.1±1.5	0.011*
Dietary fiber (g)	3.7±0.7	3.2±1.0	0.327	0.9±0.2	1.2±0.3	0.017*
P:F:C	20:22:58	18:29:53		3:30:67	9:37:54	

Data are shown in mean ± SD. *$P < 0.05$, control vs. intervention periods, Wilcoxon's signed rank test
P = protein; F = fat; C = carbohydrate

Table 5. Energy and nutrient intakes at before the study, control and intervention periods

	Before the study	Control period	Intervention period	*P value*
Energy (kcal)	1,299±205	1,312±153	1,511±190	0.012*
Lipid (g)	28.3±6.7	32.9±6.3	45.9±8.9	0.012*
Protein (g)	48.1±5.4	51.7±5.0	53.7±6.9	0.674
Carbohydrate(g)	213.1±38.4	203.7±27.7	220.9±27.4	0.036*
Saturated fat (g)	7.7±2.4	10.4±4.8	15.5±3.0	0.012*
Cholesterol (mg)	116.7±49.9	166.2±74.5	202.2±41	0.575
Dietary fiber (g)	8.4±2.6	10.1±2.8	7.9±1.8	0.036*
P:F:C	15:19:66	16:23:61	14:27:59	

Data are shown in mean ± SD. *$P < 0.05$, control vs. intervention periods, Wilcoxon's signed rank test.
P = protein; F = fat; C = carbohydrate

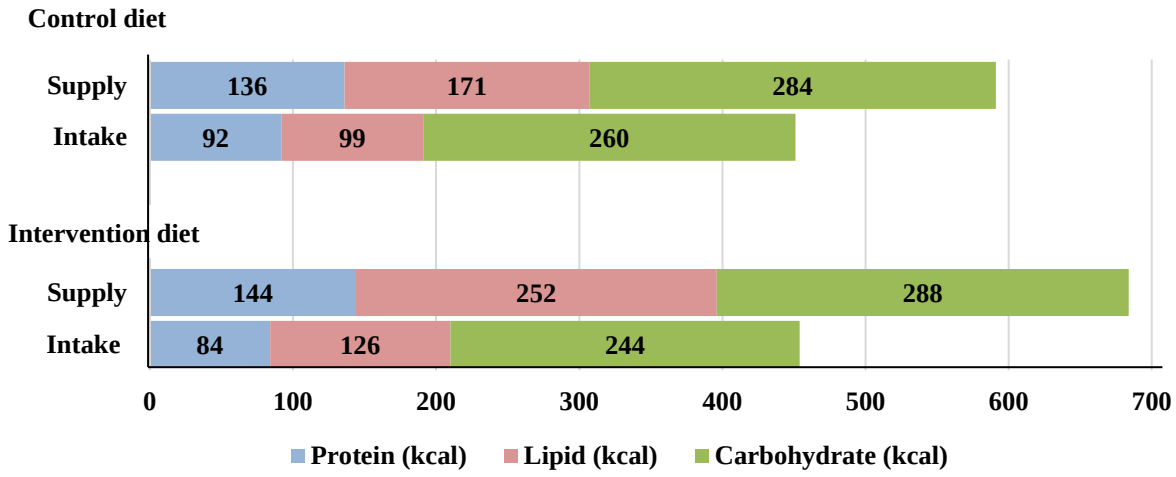

Fig 1. Energy and major nutrient intakes from lunch

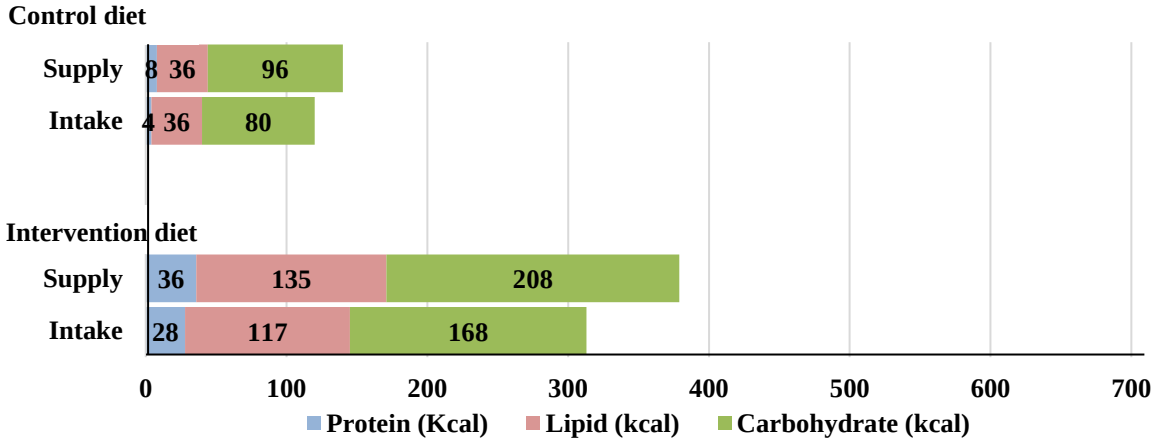

Fig 2. Energy and major nutrient intakes from snacks

DISCUSSION

This study was a small-scale preliminary study conducted before the main study. The main purpose was how to increase energy intake in older adults at risk of malnutrition. However, we found that in undernourished older adults, increasing energy from lipid-fortified meals was difficult but that snacks were acceptable.

We tried to use oleic acid-rich oils, e.g. rice bran oil was used in the lunch dishes, and ground peanuts were used in some snacks because there were reports that showed oleic acid is more acceptable in elderly with poor appetites (4, 7).

However, before we designed the type of lipid for the lunch dishes and snacks, we tried to use various types and amounts of lipid and conducted an acceptability test a small number of elderly and researchers; after that the recipes with the highest acceptance scores were chosen for the intervention study.

However, our present study was not successful in increasing energy intake at lunch. In the regular meal diet, we gave about 600 kcal and the intake was about 455 kcal. We increased the intervention lunch to about 700 kcal but the actual intake was about 450 kcal. Intake of all the 3 major nutrients was the same, indicating that the increased lipids were not taken. Conversely, the study of Faxén-Irving et al (7) showed the positive effect of energy-dense oleic acid-rich supplement (30 ml, 3 times/ day), which increased energy intake about 390 kcal higher in the intervention group compared to the control group and indicated better appetite. This may be because offering the small but frequent energy dense oleic acid-rich supplement stimulated appetite and resulted in increased energy intake.

Our present study reported that energy rich snacks with coconut milk/ ground peanuts and a box of soy milk were successful and energy intakes became 2.5 times higher than the regular snacks (control 122 ± 34, intervention 313 ± 48 kcal, $P = 0.012$).

The above results may indicate that the participants could not consume large portions of

high energy foods, especially lipids, suggesting the digestion of lipids is not smooth but if the lipid amount is less than about 125 kcal in each meal and snack, they could eat the whole amount. Therefore, we concluded that for the elderly, small, frequent portions are easier than large amounts in a few meals and the upper limit of lipids may be approximately 125 kcal (25 - 30% of total energy).

This is supported by some reports that mention that although foods high in energy from lipids tend to be more palatable, the elderly may not eat them in large amounts because of some symptoms such as gastric distention and emptying rates (8). Some studies showed that the elderly have significantly reduced enzyme secretions such as lipase, chymotrypsin, and amylase compared with younger people (4, 10).

On average older adults eat more slowly, are less hungry, and consume smaller meals than young people do. Small meals or snacks have been used to improve dietary intake. For example, Kruizenga et al (11) reported that if they offered two snacks per day to frail malnourished hospital patients, they found that the intervention group increased intake by approximately 600 kcal and 12 g protein/day compared to the control group (no snacks).

The taste, variety, familiarity, and portion size of the fortified foods and snacks may lead to a higher rate of consumption and preference (12). In this study, the average acceptability of appearance, aroma, texture, taste, and overall appeal of both the control and intervention diet were found to be similar. All of the participants were satisfied with the portion size of the supply of snacks. On the other hand, some of them informed us that the portion size of the supplied lunches was too large.

This study was the preliminary study for the following main study to find a good method for increasing energy. Although the number of subjects was small and the study period brief, our finding that a higher energy lunch with fortified oil was not effective but increasing energy with frequent snacks with slightly higher energy may be preferable is significant. In the subsequent main study, we will adopt this finding (frequent and higher energy).

CONFLICT OF INTERESTS

The authors declare no conflict of interests regarding the publication of this article.

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