Effectiveness of *Cosmos caudatus* in improving sarcopenia indices, dietary intake and physical fitness among older adults with probable sarcopenia and definitive sarcopenia in Kelantan

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OVERVIEW

01 INTRODUCTION

02 METHODOLOGY

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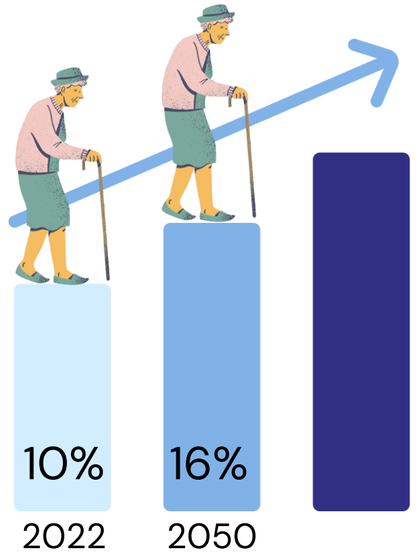
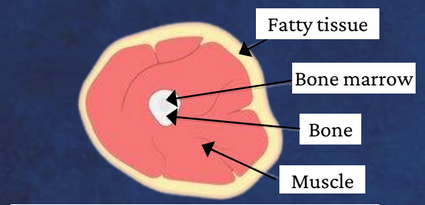
Population aging



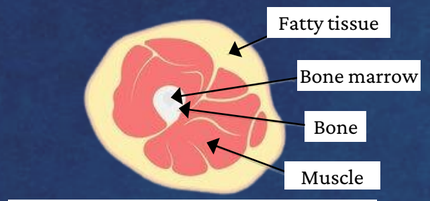
By 2050, the number of older adults will be twice the number of children under age 5 and almost equivalent to the number of children under 12 years.

(United Nations, 2020)

Sarcopenia



Healthy muscle mass



Muscle loss in sarcopenia

Sarcopenia is an age-related disease with a gradual loss of skeletal muscle mass, muscle strength and loss of muscle function

(Papadopoulou, 2020)

PREVALENCE OF SARCOPENIA

1% - 30%

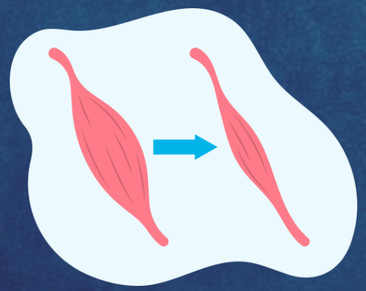
EWGSOP guideline

4.1% - 11.5%

AWGS 2019 guideline

(Ramoo et al., 2022)

Poor dietary intake



Sarcopenia

Physical inactivity

(Schoufour et al., 2021; Vafa et al., 2020)

Preventing age-related loss of muscle mass and function through their roles as exogenous antioxidant and anti-inflammatory agents

(Nazri et al., 2022)

Antihypertensive, antidiabetic, anti-inflammatory and neuroprotective

Rich in polyphenols

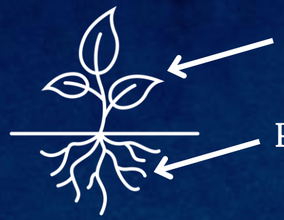
(You et al., 2018)

Cosmos caudatus (*C. caudatus*)

Locally known as *ulam raja* (kings of *ulam*)

(You et al., 2021)

Phytochemical contents



Flavonoids, tannins, phenolic acid, carbohydrates, minerals, vitamins & sesquiterpene lactones

Phenylpropanoids

(Moshawih et al., 2017)

Benefit for muscle health:

- Flavonoids:
  - ⩥ Quercetin - inhibit inflammatory receptors and their signalling pathway to decrease muscle atrophy
  - ⩥ Catechin- improve muscle mass, strength, and body endurance by
    1) maintain protein synthesis and degradation balance to slow down the muscle atrophy
    2) enhance mitochondrial biogenesis in muscle and provide sufficient energy for physiological activities
- Phenolic acid - promote muscle growth and/or reduce muscle wasting while enhance the mitochondrial quality and reduce inflammation and oxidative stress

(Le et al., 2014; Li et al., 2020; Nikawa et al., 2021)

PROBLEM STATEMENT

01

Prevalence in Malaysia:

Iskandar et al. (2021)
- 20.4% probable sarcopenia

Ranee et al. (2022), in Klang Valley
- 11.2% probable sarcopenia, 14.5% sarcopenia, 7.1 severe sarcopenia

Foo et al. (2023)
- 12.6% sarcopenia

Nazri et al. (2023)
- 41% overall sarcopenia, 22.2% sarcopenia, 18.8 severe sarcopenia

Effects of sarcopenia:

↑ risk of falls, disability, and morbidity
- prolonged hospital admission and/or long-term care placement might be needed

↓ Quality of life, ↑ mortality risk
- higher burden to the patients, family members and healthcare systems.

(Foo et al., 2023; Ziaaldini et al., 2017)

02

Studies of *Cosmos caudatus*

- Most of the studies are limited to in-vivo and in-vitro studies but the clinical effect of *C. caudatus* in humans still obscure.

Cheng et al. (2015)
- A randomized controlled trial among subjects with type 2 diabetes
- eight weeks supplementation of *C. caudatus* could improve insulin resistance, C-Reactive Protein (CRP), serum metabolite levels of branched-chain amino acid in the intervention group

You et al. (2021)
- A 12-week supplementation with *C. caudatus* among older adults with cognitive impairment reported significant improvement in blood oxidative stress marker, cognitive function, and mood status

- To date, no studies had used *C. caudatus* as an intervention among sarcopenic older adults.

STUDY OBJECTIVES

01 To investigate the effectiveness of supplementation using *Cosmos caudatus* extract in improving sarcopenia indices of older adults with probable sarcopenia and sarcopenia

02 To investigate the effectiveness of supplementation using *Cosmos caudatus* extract in improving dietary intake of older adults with probable sarcopenia and sarcopenia

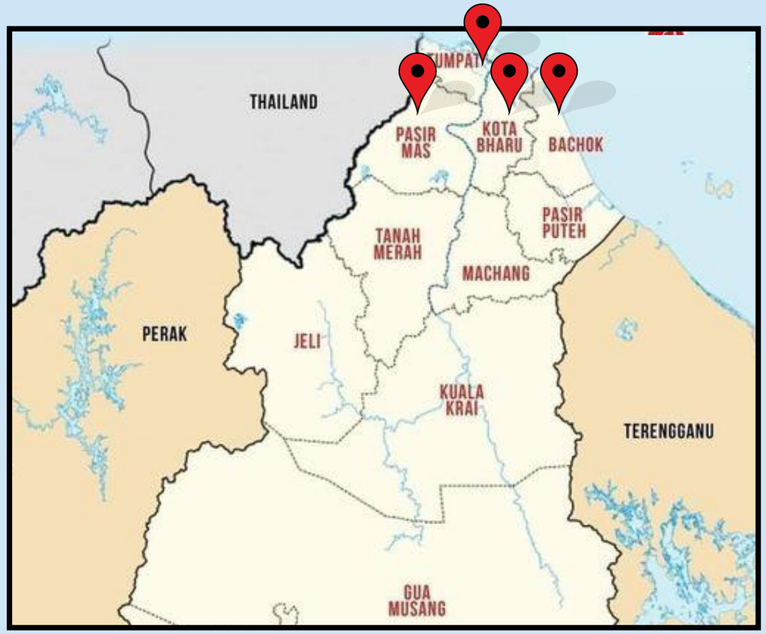
03 To investigate the effectiveness of supplementation using *Cosmos caudatus* extract in improving physical fitness of older adults with probable sarcopenia and sarcopenia

METHODOLOGY

Study design

A 12-week double blind placebo controlled randomized trial

Study location



Sample size

- Calculated using the formula by Chan (2003)
- 92 subjects were recruited with post-intervention standard deviation of 7.3, 90% power, and 95% confidence interval with an additional drop-out rate of 30%.
- The mean and standard deviation chosen were based on the study by Takeuchi et al. (2018)

Inclusion criteria

- ✓ Older adults age 60 years and above
- ✓ Has probable sarcopenia and definitive sarcopenia diagnosed using AWGS 2019 guidelines
- ✓ Non-smoking
- ✓ Not taking any other vitamin, herbal or traditional medications
- ✓ Similar pattern of fruits and vegetables consumption

Exclusion criteria

- ✗ Older adults who are undergoing regular hemodialysis, bedridden, hospitalised / on tube feeding
- ✗ Older adults with severe sarcopenia (meeting all 3 criteria)
- ✗ Older adults with chronic kidney diseases, diarrhea, chronic constipation or gastrointestinal diseases such as inflammatory bowel disease, irritable bowel syndrome, haemorrhoid, diverticulitis
- ✗ Older adults on antibiotics for the past 30 days, corticosteroid, immunosuppressants, warfarin therapy or on medications affecting intestinal motility such as laxatives, antidepressants, opioid, anticholinergic, prebiotic and probiotic during the study period
- ✗ Older adults living in a long-term care facility

Randomization and Allocation

The randomization sequence of the subjects were generated using a randomization website (https://www.randomization.com) by simple randomization. The villages were randomized to either the control or the treatment group with a 1:1 allocation ratio.

Intervention

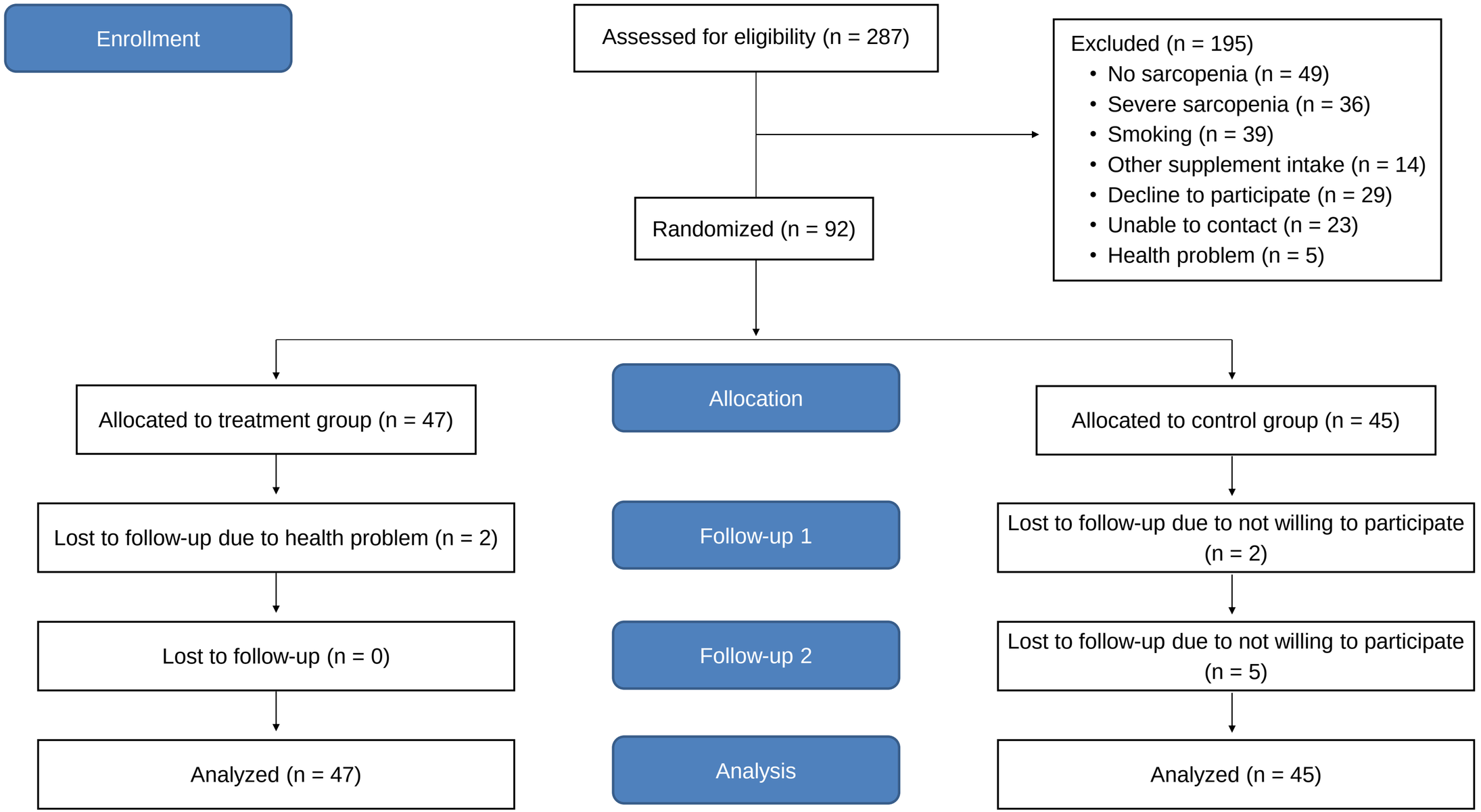
The treatment group will receive 500 mg of *C. caudatus* extract, while the control group will receive a similar dose of maltodextrin daily for 12 weeks taken before breakfast, daily with health diet counselling for both groups.

-Maltodextrin chosen due to no therapeutic effect

Adherence & Compliance

- Weekly telephone calls were made to monitor adherence and address subjects' concern (eg: presence of any side effects).
- Compliance were monitored by the researcher by asking the subjects to return the supplement bottle every month.
- Subjects were given a small diary to mark the chart daily after consuming the supplements

STUDY FLOWCHART



STUDY OUTCOMES

01 Changes in Sarcopenia Indices

- Diagnosed using Asian Working Group for Sarcopenia (AWGS)

Muscle mass

- Measured using Karada Scan Omron Body Composition Monitor
- SMI: (muscle mass/height2)
- Low muscle mass: SMI values of <7 kg/m² for men and <5.7 kg/m² for women

Muscle strength

- Hand grip strength was measured using hydraulic hand dynamometer
- Poor handgrip strength<28 kg for men and <18 kg for women

Physical performance

- Assessed using SPPB
- Consisted of three major assessments: the gait speed, balance tests and a chair stand test
- Poor physical performance: score ≤9

Skeletal Muscle Index (SMI)	Handgrip strength	SPPB score	Sarcopenia Status
Normal	Normal	Normal	No sarcopenia
Normal	Normal	Low	Probable sarcopenia
Normal	Low	Low	Probable sarcopenia
Normal	Low	Normal	Probable sarcopenia
Low	Normal	Normal	Probable sarcopenia
Low	Normal	Low	Sarcopenia
Low	Low	Normal	Sarcopenia
Low	Low	Low	Severe Sarcopenia

(Chen et al., 2020)

STUDY OUTCOMES

02 Changes in Dietary Intake

- Assessed using Dietary History Questionnaire (DHQ)
- Taken for seven days via interview administered method
- Data was collected using household cooking utensils such as teaspoon, dessertspoon, teacup, various sizes of bowls, rice scoop, and plates.
- Intake was analysed using Nutritionist Pro Software and was compared with the Malaysian Recommended Nutrient Intake (RNI) 2017.

03 Changes in Physical Fitness

- Comprises of SPPB, handgrip test, back scratch test, 2-minute step test, timed-up and go test and chair sit and reach test

Back scratch test

- To assess upper body flexibility in the shoulder joint and shoulder arch on both the left and right sides
- The subject will be required to place one hand behind the head, reaching over the shoulder and one hand up the middle of the back.
- The distance in cm between the extended middle fingers will be recorded.
- If the fingertips touch, then the score will be 0.

2-minute step test

- To assess aerobic capacity thus evaluating subjects' level of functional fitness.
- The subject will be required to stand next to a wall while a mark is placed on the wall at the level that corresponds to the midway between the patella and iliac crest (top of the hip bone).
- The number of times the right knee reaches the point midway between the patella and iliac crest within 2 minutes will be recorded.

(Lohne-Seiler et al., 2016; Bohannon & Crouuch, 2019; Mayogra-Vega et al., 2016)

STUDY OUTCOMES

03 Changes in Physical Fitness

- Comprises of SPPB, handgrip test, back scratch test, 2-minute step test, and chair sit and reach test

Timed-up and go test

- For balance and mobility
- Subject get up from chair, walk for 3 meters , turn around and walk back to chair to sit
- Score recorded as the fastest time to complete

Chair sit and reach test

- To assess lower body flexibility
- The subject will be required to sit on a chair and one foot must remain flat on the floor. The other leg is required to be extended forward with the knee straight. Subject must use their hands to reach towards their toes by bending at the hip.
- The distance is measured between the tip of the fingertips and the toes (cm)

(Lohne-Seiler et al., 2016; Bohannon & Crouuch, 2019; Mayogra-Vega et al., 2016)

STATISTICAL ANALYSIS

BASELINE

Independent-t-test
Chi-Square test

INTERVENTION

- Data analysed using intention-to-treat method
- Missing data were handled using multiple imputation method
- Differences between treatment & control group over time were analyzed using generalized linear model repeated measure analysis.
- Effect size computed using Cohen`s d

RESULTS & DISCUSSION

Baseline Findings

Variable	Intervention (n=47)	Control (n=45)	p-value
Demographic			
Age, years	67.68(5.49)	70.49(6.90)	0.033*
Gender			0.216
Men	29(61.7)	22(48.9)	
Women	18(38.3)	23(51.1)	
Education years, years	10.26(3.30)	4.38(4.15)	<0.001*
Income, MYR	1720.21(1516.42)	830.32(494.07)	<0.001*
Marital status			0.001*
Married	34(72.3)	17(37.8)	
Not married	3(6.4)	14(31.1)	
Divorced	10(21.3)	14(31.1)	
Working status (past)			<0.001*
Government	24(51.1)	3(6.7)	
Private	5(10.6)	6(13.3)	
Own job	10(21.3)	23(51.1)	
Not working	8(17.0)	13(28.9)	
Living status			0.216
Husband/Wife only	14(29.8)	10(22.2)	
Husband/Wife and children	21(44.7)	17(37.8)	
Children only	9(19.1)	13(28.9)	
Relatives	1(2.1)	1(2.2)	
Alone	2(4.3)	3(6.7)	
Others	0(0.0)	1(2.2)	

*Significant using Independent-t-test/Chi-Square test

- Participants in the intervention group: younger, had higher education & better income ($p<0.05$)

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- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed (p<0.05)

Baseline Findings

Anthropometry/Body Composition			
Weight, kg	64.21(11.66)	61.58(8.49)	0.109
Height, cm	157.50(8.12)	156.77(7.18)	0.324
BMI, kg/cm2	25.93(4.51)	25.12(3.52)	0.168
Waist circumference, cm	88.73(10.92)	88.52(10.16)	0.462
Hip circumference, cm	94.43(8.79)	94.74(6.24)	0.380
MUAC, cm	28.96(3.40)	28.14(2.90)	0.087
Calf circumference, cm	34.69(3.69)	33.46(2.71)	0.030*
Muscle mass (%)	27.63(3.90)	26.17(3.52)	0.037*
Fat mass (%)	30.95(7.27)	33.22(6.62)	0.058

- Participants in the control group: low calf circumference & muscle mass(p<0.05)

- Participants in the intervention group: better muscle strength, SPPB score, TUG, 2-min step test & gait speed (p<0.05)

Variable	Intervention (n=47)	Control (n=45)	p-value
Physical fitness			
Muscle strength, kg	25.02(6.89)	21.24(7.50)	0.007*
SPPB, score	9.62(1.81)	8.59(2.54)	0.005*
Back scratch, cm	-11.83(10.11)	-13.01(10.67)	0.301
TUG, seconds	11.24(2.75)	13.86(3.46)	<0.001*
2-min step test, steps	60.92(34.71)	49.29(25.70)	0.028*
Chair-sit-and reach, cm	-1.58(13.18)	-4.23(11.79)	0.154
Gait speed, seconds	4.74(1.19)	6.03(1.55)	<0.001*

*Significant using Independent-t-test

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Baseline Findings

Variable	Intervention (n=47)	Control (n=45)	p-value
Dietary Intake (macronutrient)			
Energy (kcal)	1391.40(379.94)	1497.64(507.57)	0.131
Protein, g	57.59(18.36)	64.66(28.21)	0.078
Carbohydrate, g	198.46(63.75)	203.98(68.76)	0.345
Fat, g	40.51(13.57)	46.61(23.54)	0.065
Dietary cholesterol, mg	207.01(146.64)	242.20(196.15)	0.165
Saturated fat, g	9.97(4.76)	11.15(8.66)	0.208
MUFA, g	7.30(3.89)	7.40(4.86)	0.455
PUFA,g	4.03(2.27)	4.13(2.76)	0.423
Fiber,g	3.42(1.91)	3.15(1.60)	0.230
Sugar, g	32.45(24.24)	30.58(25.23)	0.359

- No significant differences in macronutrient intake between both groups

*Significant using Independent-t-test

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- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Baseline Findings

Variable	Intervention (n=47)	Control (n=45)	p-value
Dietary Intake (vitamin)			
Vitamin A, RE	553.90(305.27)	516.37(272.76)	0.268
Vitamin C, mg	68.24(47.79)	72.15(32.47)	0.325
Vitamin D, µg	2.34(2.15)	3.07(3.24)	0.103
Vitamin E, mg	2.62(1.40)	2.59(1.58)	0.466
Thiamin, mg	0.65(0.23)	0.68(0.27)	0.282
Riboflavin, mg	1.14(0.45)	1.06(0.39)	0.194
Niacin, mg	11.52(4.28)	11.61(6.13)	0.470
Pyridoxine, mg	0.71(0.45)	0.60(0.39)	0.108
Folate, µg	56.23(26.34)	61.38(33.31)	0.206
Cobalamin, µg	1.87(2.91)	2.36(3.00)	0.212
Biotin, µg	3.22(2.13)	3.50(2.35)	0.274
Pantothenic acid, mg	0.29(0.52)	0.18(0.37)	0.113
Vitamin K, µg	9.35(13.92)	14.72(4.21)	0.095

- No significant differences in vitamin intake between both groups

*Significant using Independent-t-test

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- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Baseline Findings

Variable	Intervention (n=47)	Control (n=45)	p-value
Dietary Intake (mineral)			
Sodium, mg	3141.83(1447.45)	3331.54(2447.35)	0.325
Potassium, mg	1313.82(674.74)	1395.54(604.95)	0.232
Calcium, mg	412.23(197.07)	471.46(352.91)	0.160
Iron, mg	10.94(5.19)	11.06(4.86)	0.452
Phosphorus, mg	812.11(714.03)	869.38(373.17)	0.216
Magnesium, mg	84.63(43.88)	84.41(59.25)	0.492
Zinc, mg	2.95(1.60)	2.38(1.48)	0.039
Copper, mg	0.37(0.19)	0.35(0.21)	0.290
Manganese , mg	0.40(0.48)	0.39(0.47)	0.983
Selenium, µg	25.38(16.12)	18.85(21.83)	0.498
Molybdenum, µg	1.47(1.81)	1.34(1.23)	0.369

- No significant differences in mineral intake between both groups

*Significant using Independent-t-test

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- ry, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Dietary Under-Over Reporting

Category	Groups					
	Intervention (%)			Control (%)		
	Baseline	6th week	12th week	Baseline	6th week	12th week
Under	**76.6**	**70.0**	**64.4**	**71.1**	**55.3**	**48.6**
Normal	19.1	22.5	28.9	20.0	28.9	35.1
Over-report	4.3	7.5	6.7	8.9	15.8	16.2

Compliance of the Study Groups

Response rate: Intervention: 95.74%, Control: 84.44%
Supplement adherence rate: Intervention: 93.14% , Control: 72%

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Results: Comparison of changes in sarcopenia indices in CC and placebo arm from baseline to the end of follow-up (12 weeks)

Parameter	Treatment (n=47)	Control (n=45)	Group effect			Time effect			Interaction effect		
			Partial eta square	Power	p-value	Partial eta square	Power	p-value	Partial eta square	Power	p-value
Sarcopenia Indices (primary outcome)											
Balance test, score			0.006	0.103	0.497	0.102	0.972	<0.001*	0.027	0.408	0.126
Baseline	3.68(0.81)	3.40(1.16)									
6th week	3.56(1.01)	3.51(1.08)									
12th week	3.93(0.36)	3.51(0.97)									
Chair stand test, sec			0.030	0.341	0.120	0.017	0.272	0.266	0.000	0.054	0.963
Baseline	14.05(3.40)	15.04(3.69)									
6th week	13.89(3.37)	14.56(3.27)									
12th week	13.69(3.16)	14.20(2.81)									
Muscle strength, kg			0.008	0.121	0.434	0.014	0.249	0.321	0.028	0.440	0.108
Baseline	25.02(6.89)	21.24(7.49)									
6th week	24.62(6.87)	23.35(6.43)									
12th week	25.26(6.57)	23.78(6.98)									

- No significant differences in sarcopenia indices between both groups

**Adjusted for age, income, education years, calf circumference, muscle mass, SMI, muscle strength, gait speed, SPPB score, TUG, two-minute step test

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Results: Comparison of changes in sarcopenia indices in CC and placebo arm from baseline to the end of follow-up (12 weeks)

Parameter	Treatment (n=47)	Control (n=45)	Group effect			Time effect			Interaction effect		
			Partial eta square	Power	p-value	Partial eta square	Power	p-value	Partial eta square	Power	p-value
Sarcopenia Indices (primary outcome)											
Fat mass, %			0.002	0.068	0.689	0.002	0.073	0.826	0.035	0.512	0.070
Baseline	30.95(7.27)	33.23(6.44)									
6th week	31.63(7.36)	31.41(5.86)									
12th week	32.27(6.69)	31.89(6.41)									
SMI, kg/m2			0.005	0.096	0.526	0.008	0.160	0.482	0.021	0.313	0.186
Baseline	7.08(1.18)	6.51(0.73)									
6th week	6.98(1.08)	6.67(0.87)									
12th week	6.82(1.08)	6.68(0.97)									
Calf Circumference ,cm			0.010	0.147	0.364	0.028	0.464	0.102	0.011	0.196	0.405
Baseline	34.69(3.69)	33.43(2.59)									
6th week	34.30(3.65)	33.41(2.53)									
12th week	34.18(3.71)	33.04(2.29)									

**Adjusted for age, income, education years, calf circumference, muscle mass, SMI, muscle strength, gait speed, SPPB score, TUG, two-minute step test

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Results: Comparison of changes in physical fitness in CC and placebo arm from baseline to the end of follow-up (12 weeks)

Parameter	Treatment (n=47)	Control (n=45)	Group effect			Time effect			Interaction effect		
			Partial eta square	Power	p-value	Partial eta square	Power	p-value	Partial eta square	Power	p-value
Physical fitness											
Back scratch, cm Baseline 6th week 12th week	-11.83(10.11) -10.56(8.96) -8.07(8.16)	-13.01(10.67) -11.17(8.90) -10.49(8.46)	0.000	0.052	0.889	0.009	0.172	0.483	0.013	0.211	0.392
Chair sit and reach, cm Baseline 6th week 12th week	-1.58(13.18) -2.85(12.18) -1.35(5.20)	-4.17(11.04) -6.31(12.69) -5.52(9.82)	0.029	0.334	0.125	0.005	0.110	0.684	0.009	0.165	0.490

- No significant differences in physical fitness between both groups

**Adjusted for age, income, education years, calf circumference, muscle mass, SMI, muscle strength, gait speed, SPPB score, TUG, two-minute step test

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Results: Comparison of changes in dietary intake in CC and placebo arm from baseline to the end of follow-up (12 weeks)

Parameter	Treatment (n=47)	Control (n=45)	Group effect			Time effect			Interaction effect		
			Partial eta square	Power	p-value	Partial eta square	Power	p-value	Partial eta square	Power	p-value
Dietary Intake											
Fat, g			0.050	0.522	0.045*	0.008	0.155	0.514	0.000	0.050	0.999
Baseline	40.51(13.57)	46.61(23.54)									
6th week	37.75(11.01)	44.99(20.38)									
12th week	39.11(13.79)	43.98(15.63)									
Cholesterol, mg			0.534	0.051	0.042*	0.009	0.168	0.495	0.000	0.051	0.996
Baseline	207.01(146.64)	242.20(196.15)									
6th week	208.59(129.01)	261.07(195.16)									
12th week	210.59(137.68)	237.43(171.17)									

No interaction effect in macro and micronutrient intake were observed between baseline till 12th week follow-up for both groups

-Significant group effect for fat & cholesterol were observed at each time point

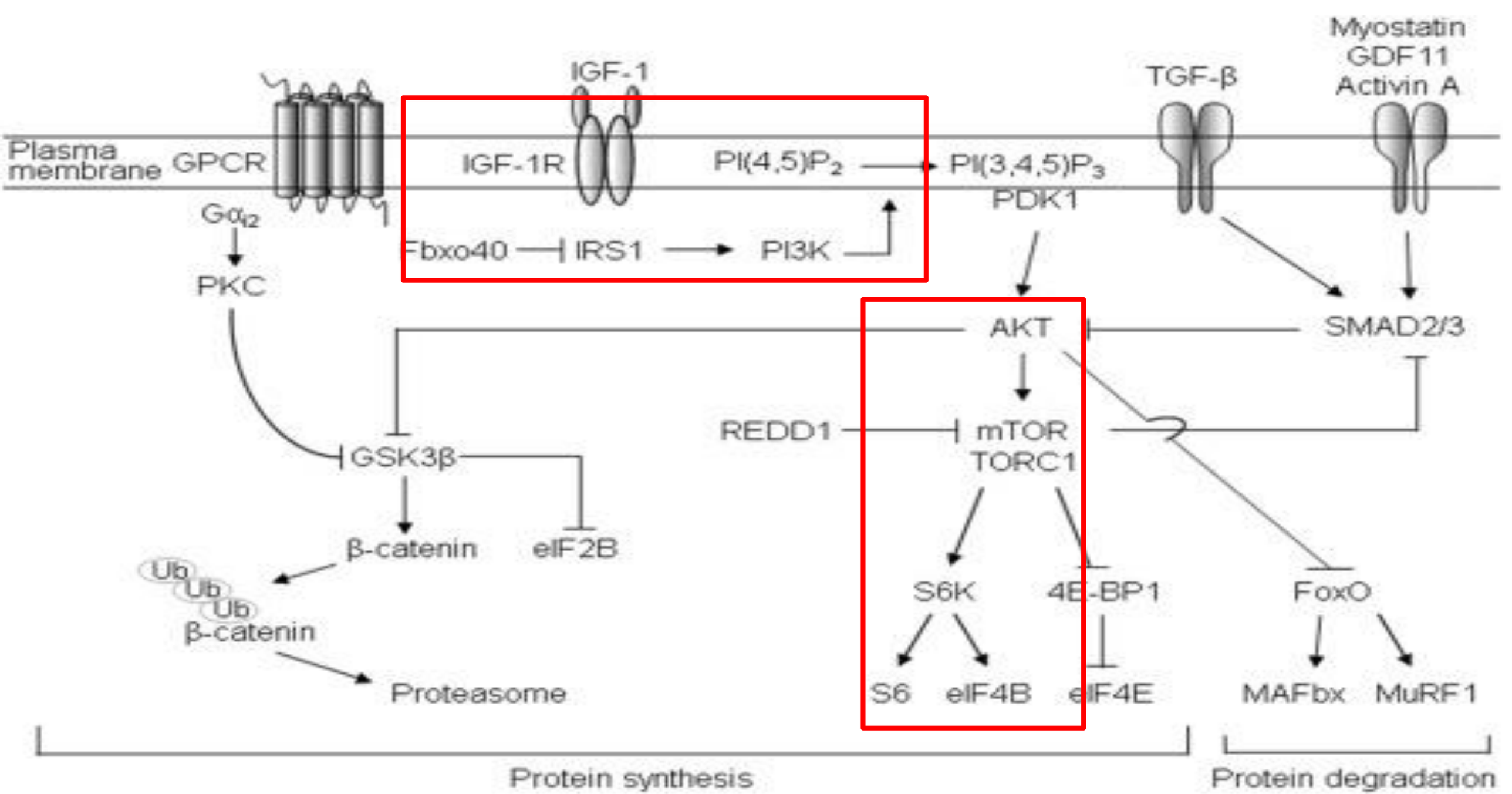
**Adjusted for age, income, education years, calf circumference, muscle mass, SMI, muscle strength, gait speed, SPPB score, TUG, two-minute step test

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

DISCUSSION

This study demonstrates that 12-week supplementation with *Cosmos caudatus* had no significant changes in sarcopenia indices, physical fitness and dietary intake among subjects with probable & definitive sarcopenia in Kelantan

- Findings from systematic review showed that intervention based on antioxidant supplementation in combination with vitamin D and protein, as well as increasing fruits & vegetables intake improved muscle strength and physical function
- (Besora-Moreno et al 2022)



Ref: Park et al (2017)

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

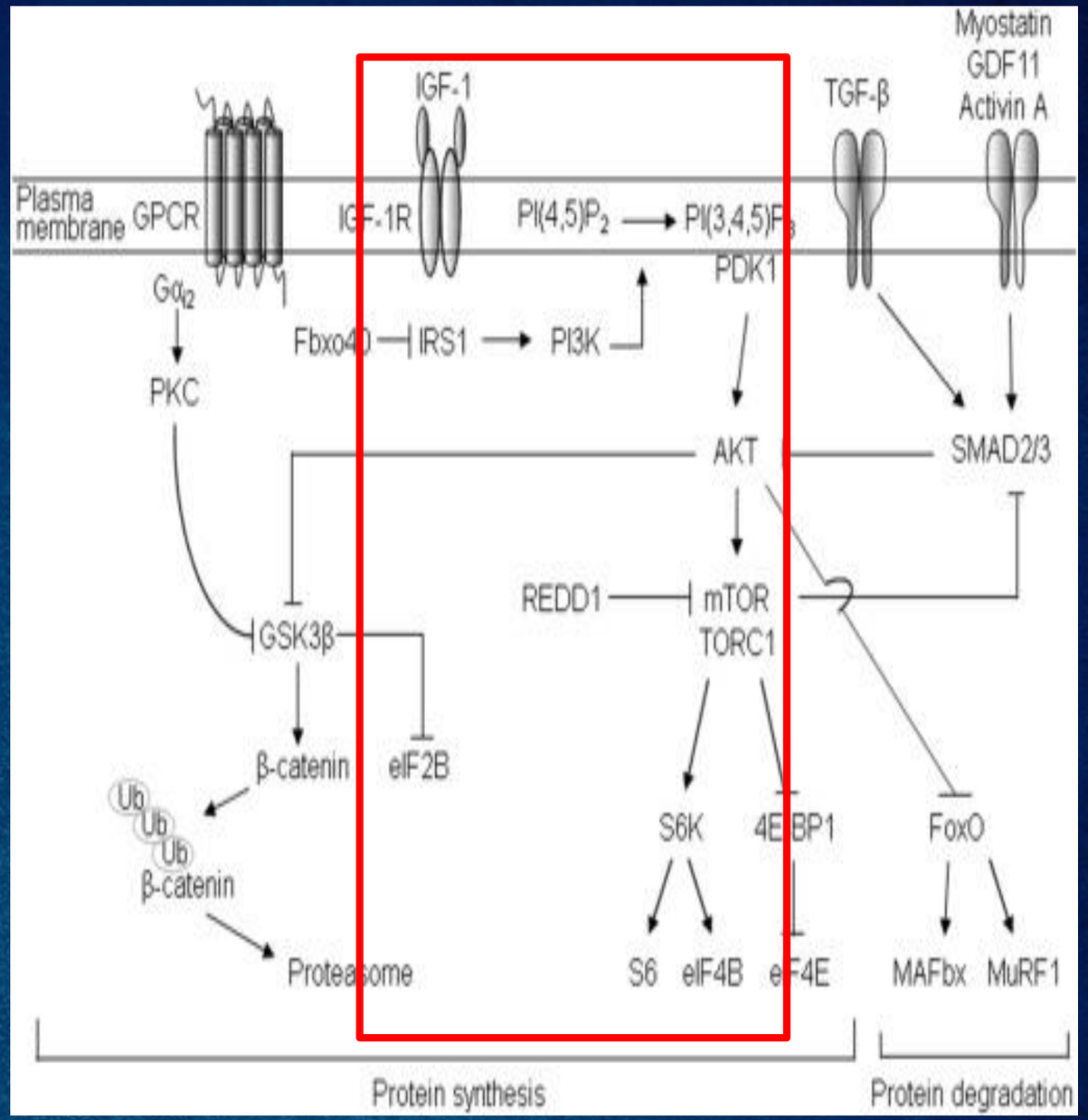
DISCUSSION

IGF-PI3K-Akt

Activates mTOR

Phosphorylates 70-kDA ribosomal protein S6 kinase

Protein synthesis



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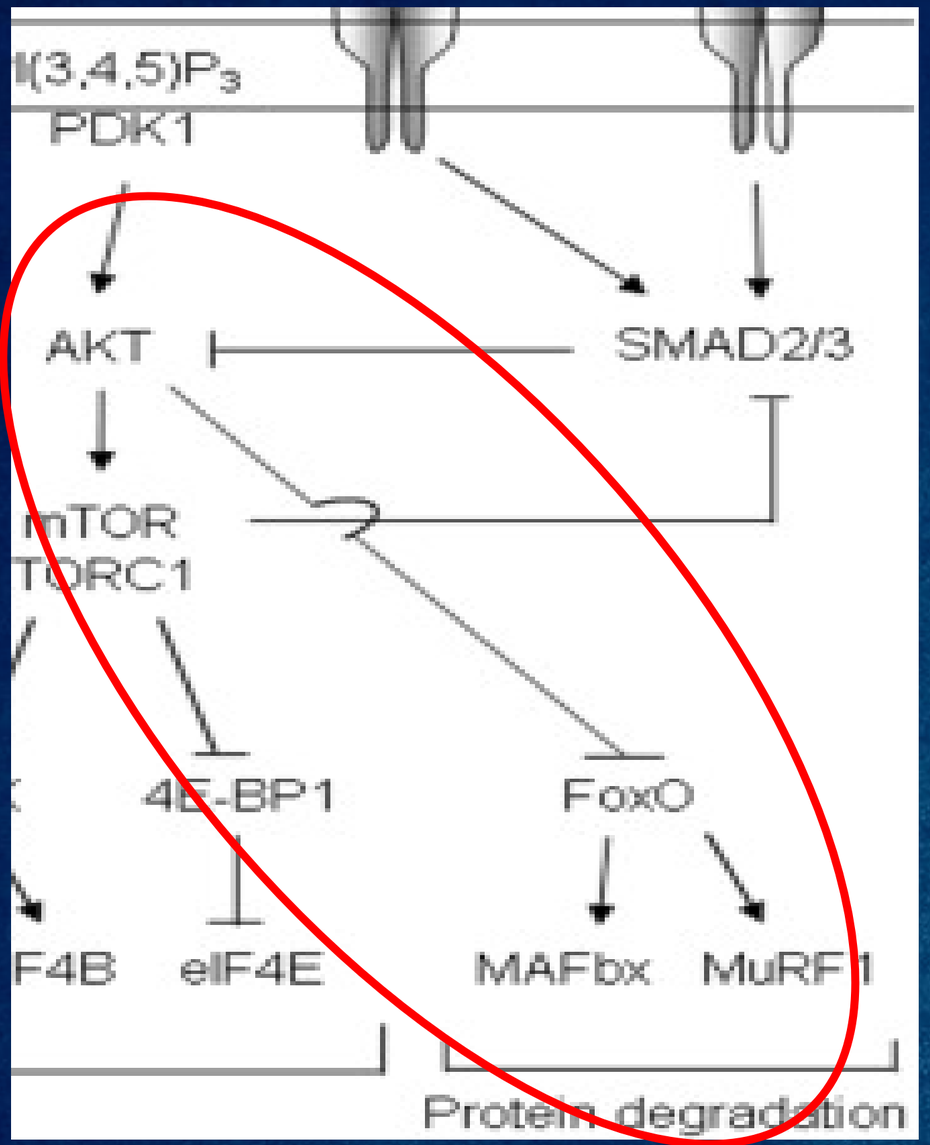
DISCUSSION



IGF-PI3K-Akt

Inhibits FOXO transcription factors

Decrease expression of MAFbx & MuRF1

Inhibit protein degradation

(*Ref: Park et al (2017)*

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

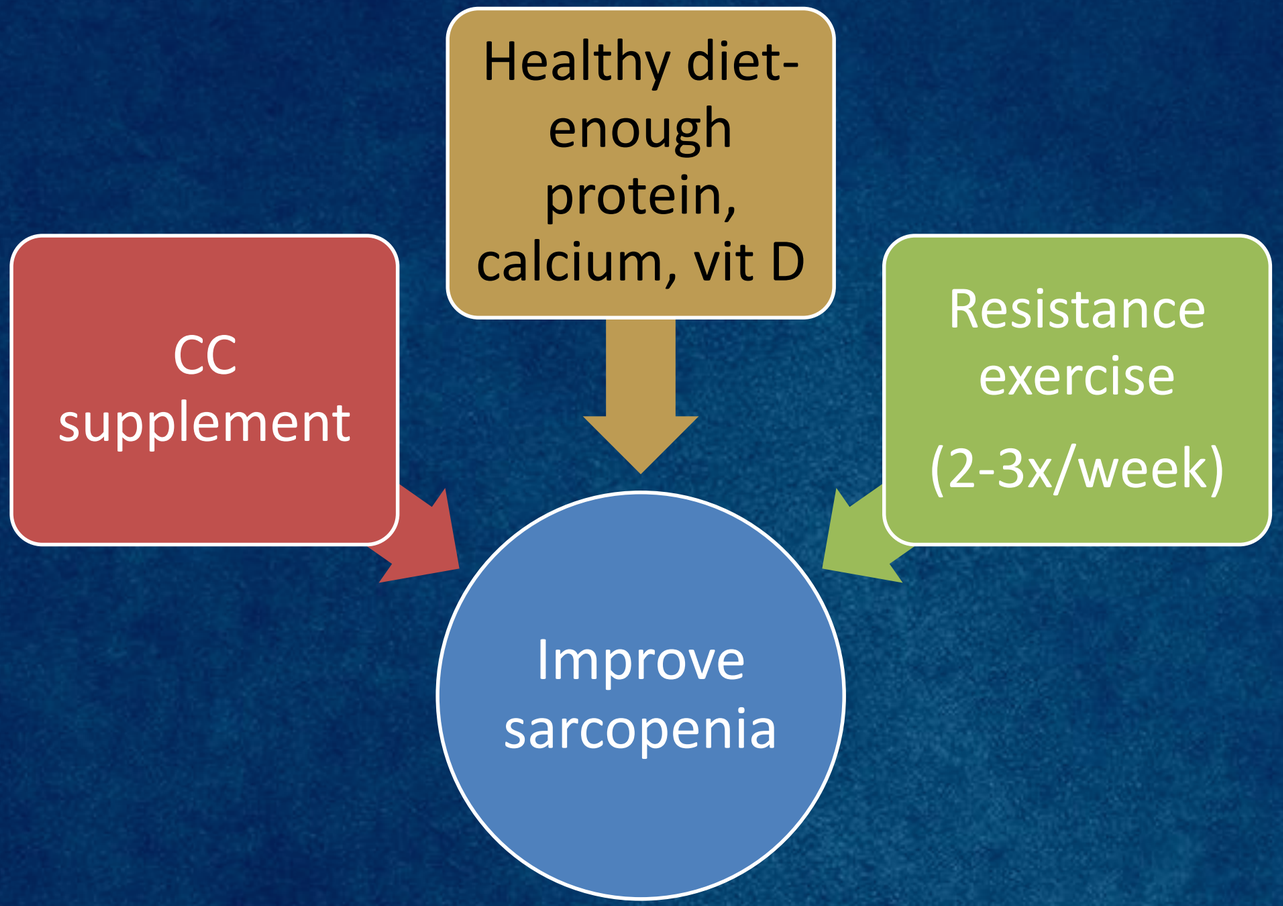
SUMMARY OF PAST INTERVENTION STUDIES

Author (year), Country	Intervention	Duration	Subjects	Main findings
Harper et al (2020), USA	Exercise & 500 mg Resveratrol, Exercise & 1000mg resveratrol, Exercise & placebo (3 arms)	12 weeks	Older adults with physical function limitations (n=60)	-Exercise + 1000 mg: 6 min walk test score was higher than other
Mafi et al (2019), Iran	Resistance training (RT) & Epicatechin (EP), RT, EP, Placebo (4 arms) Dose EP: 1 mg pure epicatechin per 1 kg BW	8 weeks	Men with sarcopenia (n=62)	-EP+RT: improvement in leg press, chest press as compared to other groups
Kim et al (2023)	Exercise + tea catechin, exercise, tea catechin, health education (4arms) Dose: 350ml/day of tea catechin	3 months	Women with sarcopenia (aged 75 yrs and older)	Combined intervention of exercise + tea catechin: improved leg muscle mass and walking

- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

CONCLUSION

Cosmos caudatus supplement alone provides less benefit in improving health outcomes among sarcopenic older adults.



- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

Current Work

:

CC supplement

IGF-P13K-AKT-mTOR

Gut microbiota

- This study is supported by the Ministry of Higher Education Malaysia for the Fundamental Research Grant Scheme (FRGS) with project code: FRGS/1/2022/SKK06/USM/02/1.

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- Participants in the intervention group: better muscle strength, muscle performance, TUG, 2-min step test & gait speed ($p<0.05$)

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