**Supplementary Table S1. Sampling locations by geographic stratum。**

| Geographic Stratum | District | Subdistrict |
|---|---|---|
| **City Center** | Changning District | Beixinjing |
| | Xuhui District | Changqiao |
| **Inner Suburbs** | Jiading District | Juyuan |
| | Pudong New Area | Tangzhen |
| **Outer Suburbs** | Fengxian District | Zhuanghang |
| | Pudong New Area | Chuansha |

To address the potential concern of conceptual overlap between the hPDI and the dietary components of the MNA, we conducted a comprehensive sensitivity analysis using a modified MNA score (mMNA) that excluded all diet-related items. The results of this analysis were substantively consistent with our primary findings, confirming the robustness of the mediating role of nutritional status.

As detailed in Supplementary Table S1, when stratifying by geographic area only, the indirect effects of hPDI on all three cognitive measures through mMNA remained statistically significant ($p < 0.01$) in the total sample and across all areas. The proportion of the total effect mediated by mMNA showed patterns highly similar to those observed with the full MNA, with notably strong mediation in the city centre and inner suburbs for MMSE and MoCA.

Furthermore, the more granular analysis stratified by both gender and geographic area (Supplementary Table S2) reinforced the key subgroup patterns identified in the primary analysis. The mediating effect of mMNA continued to be most pronounced and consistent in the city centre for both genders. Crucially, the finding that the association in the outer suburbs is primarily driven by females was replicated, with significant indirect effects through mMNA observed for females but not for males across all cognitive outcomes.

In summary, the persistence of significant mediation effects through the diet-independent mMNA score strongly indicates that the pathway from a healthful plant-based diet to better cognitive function via improved nutritional status is not an artifact of measurement overlap. Instead, it represents a robust relationship that encompasses broader, systemic aspects of

nutritional well-being beyond mere dietary intake frequency.

**Supplementary Table S2. Mediation Analysis of hPDI on Cognitive Function through the Modified MNA (mMNA), Stratified by Geographic Area.**

| Impact Pathway | Area | Total effect | Direct effect | Indirect effect | Proportion | 95% CI |
|---|---|---|---|---|---|---|
| **hPDI→MMSE** | Total | 0.083** | 0.041** | 0.042** | 50.60% | 0.031, 0.052 |
| | City Center | 0.044** | 0.019** | 0.023** | 69.35% | 0.014, 0.036 |
| | Inner suburbs | 0.068** | 0.025** | 0.043** | 63.24% | 0.025, 0.061 |
| | Outer suburbs | 0.164** | 0.115** | 0.049** | 29.88% | 0.027, 0.072 |
| **hPDI→MOCA** | Total | 0.074** | 0.034** | 0.040** | 54.05% | 0.029, 0.052 |
| | City Center | 0.035** | 0.007** | 0.028** | 80.00% | 0.017, 0.039 |
| | Inner suburbs | 0.072** | 0.029** | 0.043** | 60.72% | 0.024, 0.062 |
| | Outer suburbs | 0.156** | 0.108** | 0.047** | 30.32% | 0.022, 0.073 |
| **hPDI→CDR** | Total | -0.058** | -0.026** | -0.032** | 55.17% | -0.040, -0.025 |
| | City Center | -0.183** | -0.096** | -0.087** | 47.54% | -0.110, -0.066 |
| | Inner suburbs | -0.029** | -0.006** | -0.023** | 79.31% | -0.036, -0.011 |
| | Outer suburbs | -0.045** | -0.018** | -0.027** | 60.00% | -0.040, -0.014 |

Note.

1. All models controlled for age, education, marital status, number of children, income, chronic diseases, BADL, IADL, depression, smoking, drinking, PASE, and environmental factors.

2. BADL (Basic Activities of Daily Living); IADL (Instrumental Activities of Daily Living); PASE (Physical Activity Scale for the Elderly); mMNA (modified Mini Nutritional Assessment); hPDI (Healthful Plant-based Diet Index); MMSE (Mini-Mental State Examination); MoCA-B (Montreal Cognitive Assessment-Basic); CDR (Clinical Dementia Rating).

3. ***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$.

**Supplementary Table S3. Mediation Analysis of hPDI on Cognitive Function through the Modified MNA (mMNA), Stratified by Geographic Area and Gender.**

| Impact Pathway | Area | Gender | Total effect | Direct effect | Indirect effect | Proportion | 95% CI |
|---|---|---|---|---|---|---|---|
| **hPDI→MMSE** | City | Male | 0.051** | 0.029** | 0.022** | 43.14% | 0.008, 0.036 |
| | Centre | Female | 0.036** | 0.014** | 0.022** | 61.11% | 0.008, 0.037 |
| | inner | Male | 0.084 | 0.052 | 0.032 | 38.10% | -0.010, 0.073 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | suburbs | Female | 0.109** | 0.058** | 0.052** | 47.27% | 0.033, 0.070 |
| | outer | Male | 0.027 | 0.007 | 0.020 | 74.07% | -0.024, 0.064 |
| | suburbs | Female | 0.229** | 0.176** | 0.053** | 23.14% | 0.028, 0.078 |
| | City | Male | 0.058** | 0.030** | 0.028** | 48.28% | 0.013, 0.043 |
| | Centre | Female | 0.045** | 0.026* | 0.019* | 42.22% | 0.003, 0.035 |
| | inner | Male | 0.128 | 0.052 | 0.076** | 59.38% | 0.029, 0.124 |
| **hPDI→MOCA** | suburbs | Female | 0.100** | 0.065** | 0.034** | 34.34% | 0.016, 0.053 |
| | outer | Male | 0.054 | 0.026 | 0.027 | 50.94% | -0.028, 0.083 |
| | suburbs | Female | 0.200** | 0.152** | 0.048** | 24.00% | 0.021, 0.075 |
| | City | Male | -0.100** | -0.017** | -0.083** | 83.00% | -0.124, -0.042 |
| | Centre | Female | -0.229** | -0.127** | -0.102** | 44.54% | -0.135, -0.069 |
| | inner | Male | -0.076 | -0.043 | -0.033* | 43.42% | -0.067, -0.001 |
| **hPDI→CDR** | suburbs | Female | -0.050** | -0.027** | -0.023** | 46.00% | -0.035, -0.011 |
| | outer | Male | -0.014 | -0.019 | -0.005 | -35.71% | -0.033, 0.023 |
| | suburbs | Female | -0.081** | -0.046** | -0.035** | 43.21% | -0.049, -0.021 |

Note.

1. All models controlled for age, education, marital status, number of children, income, chronic diseases, BADL, IADL, depression, smoking, drinking, PASE, and environmental factors.

2. BADL (Basic Activities of Daily Living); IADL (Instrumental Activities of Daily Living); PASE (Physical Activity Scale for the Elderly); mMNA (modified Mini Nutritional Assessment); hPDI (Healthful Plant-based Diet Index); MMSE (Mini-Mental State Examination); MoCA-B (Montreal Cognitive Assessment-Basic); CDR (Clinical Dementia Rating).

3. ***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$.

| **Dietary Information - Food frequency questionnaire** | | | | | |
|---|---|---|---|---|---|
| How often do you consume the following foods? | Almost every day | Weekly≥1times | Monthly≥1times | Occasionally | Rarely or never |
| 1.Whole grains | | | | | |
| 2.Fruits | | | | | |
| 3.Vegetables or vegetable juice | | | | | |
| 4. Nuts | | | | | |
| 5. Legumes and soy products | | | | | |
| 6. Vegetable oil | | | | | |
| 7. Tea | | | | | |
| 8. Coffee | | | | | |
| 9. Pure squeezed fruit juice | | | | | |
| 10. Sugary drinks | | | | | |
| 11. Refined grains | | | | | |
| 12. Potato products (such as fries, mashed potatoes, potato chips) | | | | | |
| 13. Candy or desserts | | | | | |
| 14. Animal fats (such as butter, lard) | | | | | |
| 15. Milk or dairy products (cream, ice cream, etc.) | | | | | |
| 16. Eggs | | | | | |
| 17. Fish or seafood | | | | | |
| 18. Meat | | | | | |
| 18-1 Red meat (such as beef) | | | | | |
| 18-2 White meat (such as | | | | | |
| 19-ther animal-based foods like pizza | | | | | |

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# Long MNA®

## Mini Nutritional Assessment

Nestlé Nutrition Institute

Name: Gender:

Age: Weight, kilograms, kg: Height, cm: Date:

Please enter the appropriate scores in the boxes to complete the screening. Sum the screened scores. If the total is 11 points or less, proceed to complete all assessments to determine the "Malnutrition Index Value."

## Screening

**A** **In the past three months, has the child reduced food intake due to loss of appetite, digestive issues, difficulty chewing or swallowing?**
**?**
0 = Significant decrease in food intake
1 = Moderate decrease in food intake
2 = No change in food intake

**B** **Weight loss over the past three months**
0 = Weight loss greater than 3 kg (6.6 lbs)
1 = Don't know
2 = Weight loss of 1–3 kg (2.2–6.6 lbs)
3 = No weight loss

**C**
0 = Requires prolonged bed rest or wheelchair use
1 = Able to get out of bed or leave wheelchair, but unable to go outside
2 = Can go outside

**D** **Have you experienced psychological trauma or acute illness in the past three months?**
0 = Yes 2 = No

**E** **Psychological Issues**
0 = Severe dementia or depression
1 = Mild dementia
2 = No psychiatric/psychological issues

**F** **Body Mass Index (BMI) (kg/m²)**
0 = BMI below 19
1 = BMI 19 to less than 21
2 = BMI 21 to below 23
3 = BMI 23 or above

**Screening** **(Maximum 14 points)**

**Score**

12–14 points: Normal nutritional status
8–11 points: At risk of malnutrition
0-7 points: Malnutrition

If a more detailed nutritional assessment is needed, please continue to questions G-R.

## Assessment

**I**
**more prescription medications daily?**
0 = Yes 1 = No

Ref. **Do you have bedsores or skin ulcers?**
0 = Yes 1 = No

**J** **How many main meals do you eat each day?**
0 = 1 meal
1 = 2 meals
2 = 3 meals

**K** **Protein Intake Indicator**
- Consumes at least one serving of dairy products (milk, cheese, or yogurt)daily Yes Yes
- Eat two or more servings of dried beans or eggs per week Yes No
- Eat meat, fish, or poultry every day Yes No

0.0 = 0 or 1 [Yes]
0.5 = 2 [Yes]
1.0 = 3 [Yes]

**L** **Do you eat two or more servings of fruits or vegetables daily?**
0 = No 1 = Yes

**M** **How many fluids (water, juice, coffee, tea, milk...) do you drink daily?**
0.0 = Less than 3 cups
0.5 = 3 to 5 cups
1.0 = More than 5 cups

**N** **Eating patterns**
0 = Requires assistance to eat
1 = Able to eat independently but with slight difficulty
2 = Able to feed independently

**O** **Self-Assessment of Nutritional Status**
0 = Perceived as malnourished
1 = Uncertain about own nutritional status
2 = Perceived no nutritional issues

**P** **How does the patient rate their health compared to others their age?**
0.0 = Worse than others
0.5 = Don't know
1.0 = Same as others
2.0 = Better than others

**Q** **Mid-Arm Circumference (MAC) (centimeters, cm)**
0.0 = MAC below 21
0.5 = MAC 21 to less than 22
1.0 = MAC 22 or above

**R** **Calf Circumference (CC) (centimeters, cm)**
0 = CC below 31
1 = CC 31 or above

Vellas B, Villars H, Abellan G, et al. *Overview of MNA® - Its History and Challenges.* J Nut Health Aging 2006; 10: 456-465.
Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for Undernutrition in Geriatric Practice: *Developing the Short-Form Mini Nutritional Assessment (MNA-SF).* J. Geront 2001; 56A: M366-377.
Guigoz Y. The Mini-Nutritional Assessment (MNA® ) *Review of the Literature – What does it tell us?* J Nutr Health Aging 2006; 10: 466-487.

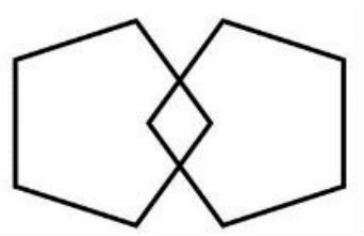
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**For more information:** www.mna-elderly.com

**Value"**

| | |
|---|---|
| Total Assessment Score 24 to 30 points | Normal Nutritional Status |
| Total Assessment Score 17 to 23.5 points | At Risk for Malnutrition |
| Total assessment score less than 17 points | Malnutrition |

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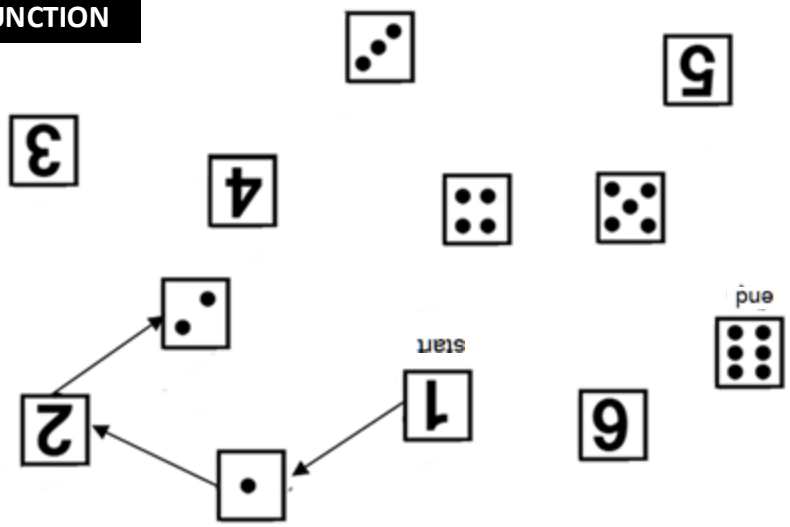
| MMSE | |
|---|---|
| Item | Question |
| Direction | 1. What year is it this year? (1 point) 2. What season is it now? (1 point)<br>3. What month is it now? (1 point) 4. What is today's date? (1 point)<br>5. What day of the week is it today? (1 point) 6. Which city are we currently in? (1 point)<br>7. What district does your home reside in? (1 point) 8. Which street (village) do you live on? (1 point)<br>9. What floor are we currently on? (1 point) 10. What place is this? (1 point) |
| Registration (Word Instant Recall) | 11. I will now name three items. After I finish, please repeat them back to me. Remember these three items, as I will ask you again later: "Ball, National Flag, Trees." You can repeat them up to 5 times.<br>Ball (1 point) National Flag (1 point) Trees (1 point) |
| Mental calculation | 12. If you have 100 yuan and spend 7 yuan, how much is left? (After the respondent answers, regardless of whether it's right or wrong) Ask, if you spend another 7 yuan, how much is left? Continue calculating this way until subtracting 5 times. Do not repeat the respondent's answers.<br>93 (1 point) 86 (1 point) 79 (1 point) 72 (1 point) 65 (1 point)<br>(Note: When the patient forgets the number after subtracting 7, do not give prompts like “93 subtract 7”; if the previous answer is wrong but the next answer derived from it is correct, only count one error.) |
| Word Recall | 13. What were the three items I asked you to remember just now? Beach ball (1 point) National flag (1 point) Tree (1 point) |
| Language Ability | 14. What is this? Watch (1 point) What is this? Pen (1 point)<br>15. Please do as written on the next page. (1 point)<br>16. Please say a complete, meaningful sentence. Write down the sentence (1 point)<br>17. Now I will say a sentence, please repeat it clearly: “Forty-four stone lions.” (1 point)<br>18. (The examiner will say the following sentence and give the participant a blank sheet of paper. Do not repeat the instructions or demonstrate): Please hold this piece of paper with your right hand (1 point), then fold the paper in half with both hands (1 point), and then place the paper on your lap (1 point). |
| Structural imitation | 19. Please draw according to the sample. Do not explain the figure (1 point).<br> |

# MONTREAL COGNITIVE ASSESSMENT (MOCA-B)

## BASIC

Name _____
Sex _____ Age ____
Education ____ Date of exam _____
Administered by _____

## EXECUTIVE FUNCTION




**SCORE**

START TIME _____

( /1)

## IMMEDIATE RECALL

Perform 2 trials even if 1st trial is successful

| | ROSE | CHAIR | HAND | BLUE | SPOON |
|---|---|---|---|---|---|
| 1st trial | | | | | |
| 2nd trial | | | | | |

No point

## FLUENCY

Name maximum numbers of **FRUITS** in 1 minute

1..... 2..... 3..... 4..... 5..... 6.....
7..... 8..... 9..... 10..... 11..... 12.....
13..... 14..... 15..... 16..... 17..... 18.....

N items

2 points if N = 13 or more
1 point if N = 8-12
0 point if N = 7 or less

( /2)

## ORIENTATION

[ ] time (± 2 hr) [ ] day [ ] month [ ] year [ ] place [ ] city

( /6)

## CALCULATION

Provide 3 ways to pay using 1 dollar coins, 5 dollar and 10 dollar bills for an object that costs exactly **"13 Dollars"** (3 points if 3 ways, 2 points if 2 ways, 1 point if 1 way, 0 point if no correct way)

[ ] 1..... [ ] 2. ..... [ ] 3. .....

( /3)

## ABSTRACTION

To what category these objects belong to ? ( e.g. orange - banana = fruit )

[ ] train - boat [ ] north - south [ ] drum - flute

( /3)

## DELAYED RECALL

Points are awarded for recall with No cue (1point for each item)

| | ROSE | CHAIR | HAND | BLUE | SPOON |
|---|---|---|---|---|---|
| Recall with No cue | [ ] | [ ] | [ ] | [ ] | [ ] |
| Recall with category cue | [ ] | [ ] | [ ] | [ ] | [ ] |
| Recall with multiple choice cue | [ ] | [ ] | [ ] | [ ] | [ ] |

( /5)

## VISUOPERCEPTION

Identify drawings. No more than 60 seconds. See complementary sheet.

| | | | | |
|---|---|---|---|---|
| scissors | T-shirt | banana | lamp | candle |
| watch | cup | leaf | key | spoon |

3 points if N = 9-10
2 points if N = 6-8
1 point if N = 4-5
0 point if N = 0-3

N __

( /3)

## NAMING

Identify animals. See complementary sheet. [ ] zebra [ ] peacock [ ] tiger [ ] butterfly

( /4)

## ATTENTION

Name the numbers in circles. See complementary sheet. 1 5 8 3 9 2 0 3 9 4 0 2 1 6 8 7 4 6 7 5

ERROR ___N
No point if 2 errors or more

( /1)

Name the numbers in circles & squares: 3 8 5 1 3 0 2 9 2 0 4 9 7 8 6 1 5 7 6 4

See complementary sheet. 1 5 8 3 9 2 0 3 9 4 0 2 1 6 8 7 4 6 7 5

ERROR ___ N
2 points if 2 errors or less
1 point if 3 errors
0 point if 4 errors or more

( /2)

END TIME _____

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**TOTAL SCORE ( /30)**

Add 1 point if education < 4 year AND add 1 point if illiterate

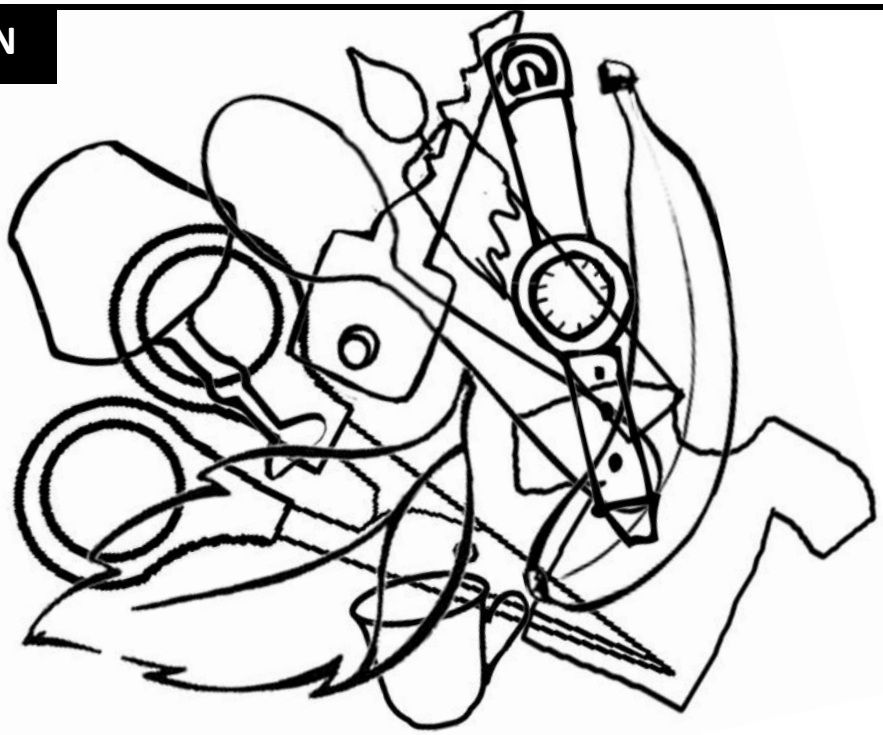
TOTAL TIME ____ min ____ sec

# MONTREAL COGNITIVE ASSESSMENT (MOCA-B)

## BASIC

**COMPLEMENTARY WORKSHEET**

### VISUOPERCEPTION



### NAMING









### ATTENTION

1 5 8 3 9 2 0 3 9 4 0 2 1 6 8 7 4 6 7 5

3 8 5 1 3 0 2 9 2 0 4 9 7 8 6 1 5 7 6 4

1 5 8 3 9 2 0 3 9 4 0 2 1 6 8 7 4 6 7 5

**Adapted by: Parunyou Julayanont MD**

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**Final Version June 04, 2014**

## CLINICAL DEMENTIA RATING (CDR) Patient's Initials_____

| CLINICAL DEMENTIA RATING (CDR) | 0 | 0.5 | 1 | 2 | 3 |
|---|---|---|---|---|---|

| | Impairment | | | | |
|---|---|---|---|---|---|
| | None<br>0 | Questionable<br>0.5 | Mild<br>1 | Moderate<br>2 | Severe<br>3 |
| Memory | No memory loss or slight inconsistent forgetfulness | Consistent slight forgetfulness; partial recollection of events; "benign" forgetfulness | Moderate memory loss; more marked for recent events; defect interferes with everyday activities | Severe memory loss; only highly learned material retained; new material rapidly lost | Severe memory loss; only fragments remain |
| Orientation | Fully oriented | Fully oriented except for slight difficulty with time relationships | Moderate difficulty with time relationships; oriented to place of examination; may have geographic disorientation elsewhere | Severe difficulty with time relationships; usually disoriented to time, often to place | Oriented to person only |
| Judgement & Problem Solving | Solves everyday problems and handles business and financial affairs well; judgement good in relation to past performances | Slight impairment in solving problems, similarities and differences | Moderate difficulty in handling problems, similarities and differences; social judgement usually maintained | Severely impaired in handling problems, similarities and differences; social judgement usually impaired | Unable to make judgements or solve problems |
| Community Affairs | Independent function at usual level in job, shopping, volunteer and social groups | Slight impairment in these activities | Unable to function independently at these activities although may still be engaged in some; appears normal to casual inspection | No pretence of independent function outside home<br>Appears well enough to be taken to functions outside the family home independent function | Appears too ill to be taken to functions outside the family home |
| Home & Hobbies | Life at home, hobbies and intellectual interests well maintained | Life at home, hobbies and intellectual interest slightly impaired | Mild but definite impairment of function at home more difficult tasks abandoned; more complicated hobbies and interests abandoned | Only simple tasks preserved; very restricted interests, poorly maintained | No significant function in home |
| Personal Care | Full capable of self-care | | Needs prompting | Requires assistance in dressing, hygiene, keeping of personal effects | Requires much help with personal care; frequent incontinence |

Score only as decline from previous usual level due to cognitive loss, not impairment due to other factors.

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