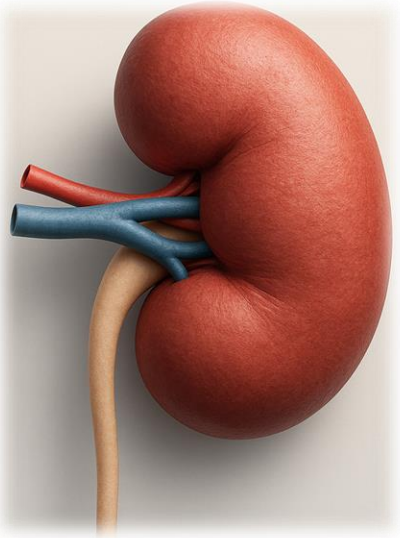
Comparing the efficacy of self-management interventions for chronic kidney disease

A systematic review and component network meta-analysis

Journal Club

16th January, 2026



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Research question

Population

Patients with CKD not receiving renal replacement therapies.

Intervention

Self-management interventions (SMIs).

Comparators

Usual care or other SMIs.

Study design

Systematic review and component network meta-analysis.

Outcomes

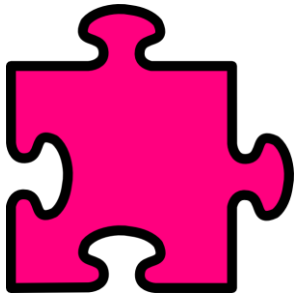
- **Renal function**
  - eGFR
- **Modifiable risk factors**
  - Systolic blood pressure (SBP)
  - Diastolic blood pressure (DBP)
  - Body mass index (BMI)
- **Patient-reported outcomes**
  - Quality of life
  - Sell-management score
  - Self-efficacy score
- **Long-term clinical outcomes**
  - Risk of death
  - Risk of developing ESKD
  - Risk of hospitalization
  - Risk of initiating renal replacement therapies

Definition of components

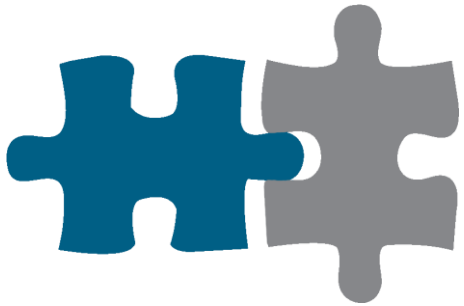
SMI components	Definition*
Edu	**Education**: Providing information and/or skills related to the nature of the disease, CKD self-management behaviors (specifically action plan), and the positive and negative of not adopting health recommendation
Diet	**Dietary**: Apply the concept of cognitive-behavioral psychology to help patients build the skills necessary to adhere to the treatment and use techniques such as reminders, memory aids, synchronizing therapeutic activities with routine life events, goal-setting, self-monitoring, contracting, skill-building, and rewards to change their dietary behaviors.
PA	**Physical activity:** Apply the concept of cognitive-behavioral psychology to help patients build the skills necessary to adhere to the treatment and use techniques such as reminders, memory aids, synchronizing therapeutic activities with routine life events, goal-setting, self-monitoring, contracting, skill-building, and rewards to improve the level of physical activity.
Psycho	**Psychosocial**: Providing support to promote positive beliefs and attitudes toward the treatment such as rapport building through frequent telephone contact, home visits, family-based approaches, and intervention to enhance self-efficacy.

** The definition of SMI components was adapted from Dhippayom et al (2022) (10.1016/j.jaip.2021.09.049). A network meta-analysis of self-management interventions for asthma patients.*

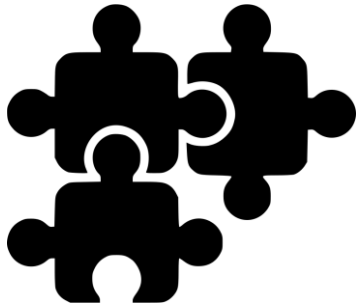
Possible SMIs



Mono-component SMIs
- Education (Edu)
- Dietary (Diet)
- Physical activity (PA)
- Psychosocial (Psycho)



Two-component SMIs
- Edu + Diet
- Edu + PA
- Edu + Psycho
- Diet + PA
- Diet + Psycho
- PA + Psycho



Three-component SMIs
- Edu + Diet + PA
- Edu + Diet + Psycho
- Edu + PA + Psycho
- Diet + PA + Psycho

Four-component SMIs
- Edu + Diet + PA + Psycho

15 self-management interventions

Why CNMA rather than SNMA?

Why CNMA rather than SNMA?

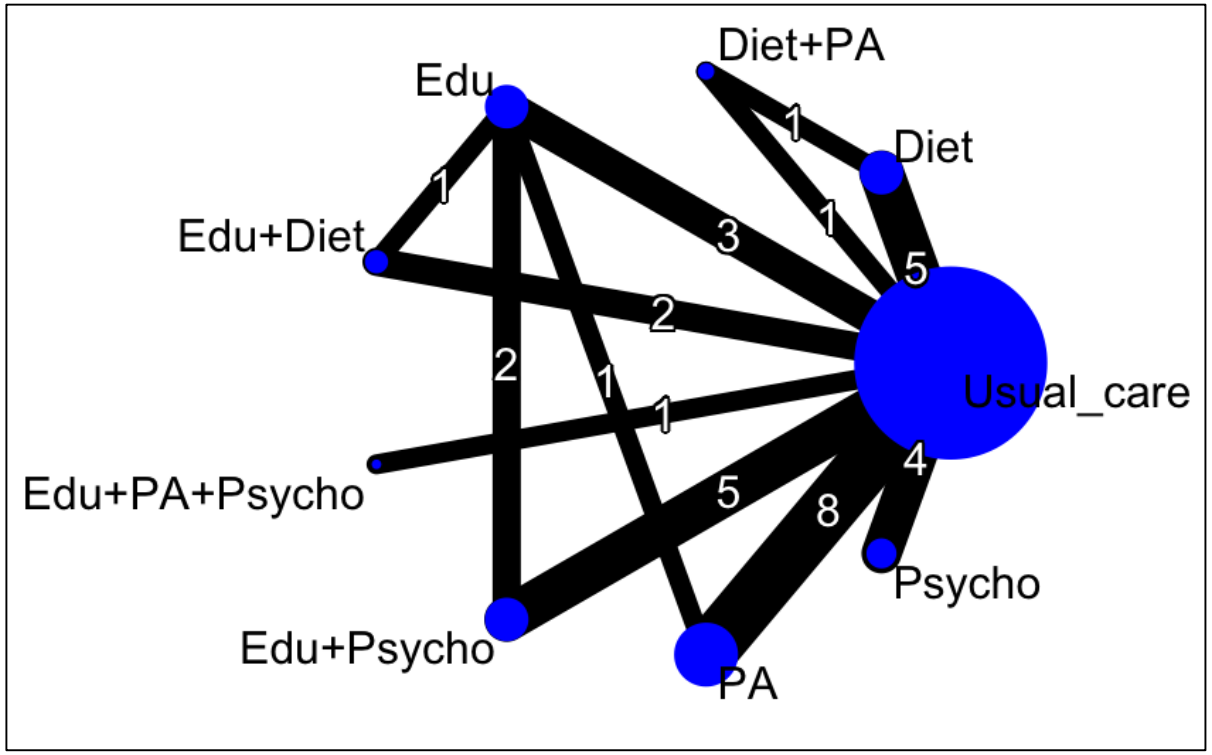


Figure: Network map for eGFR outcome

This network map:

- Sparse network.
- **8 interventions** + usual care.
- 12 direct comparisons.
- PA vs Usual care was the most common.

(Standard) network meta-analysis (SNMA)

Which type of intervention has the greatest probability of being most effective?

Why CNMA rather than SNMA?

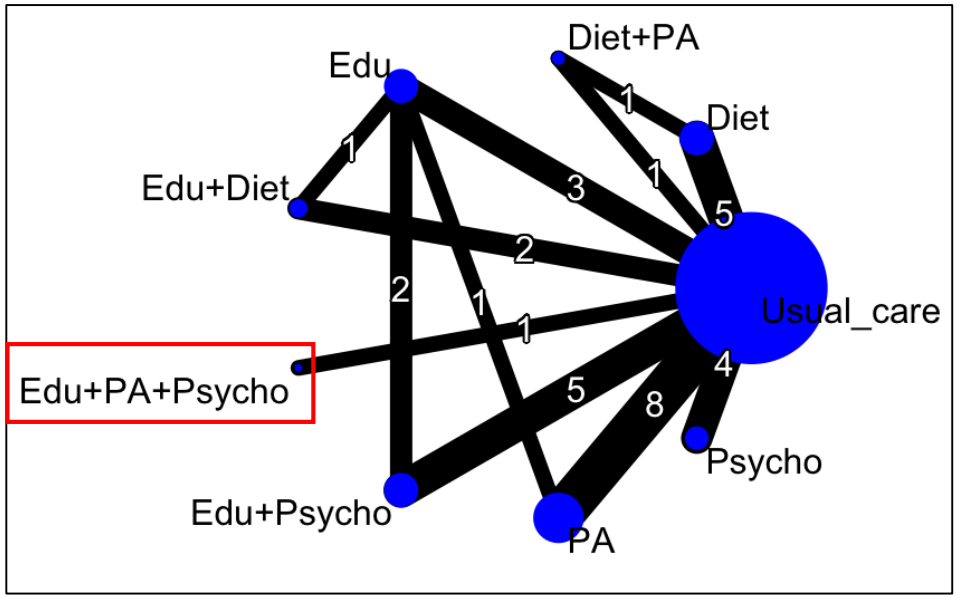


Figure: Network map for eGFR outcome

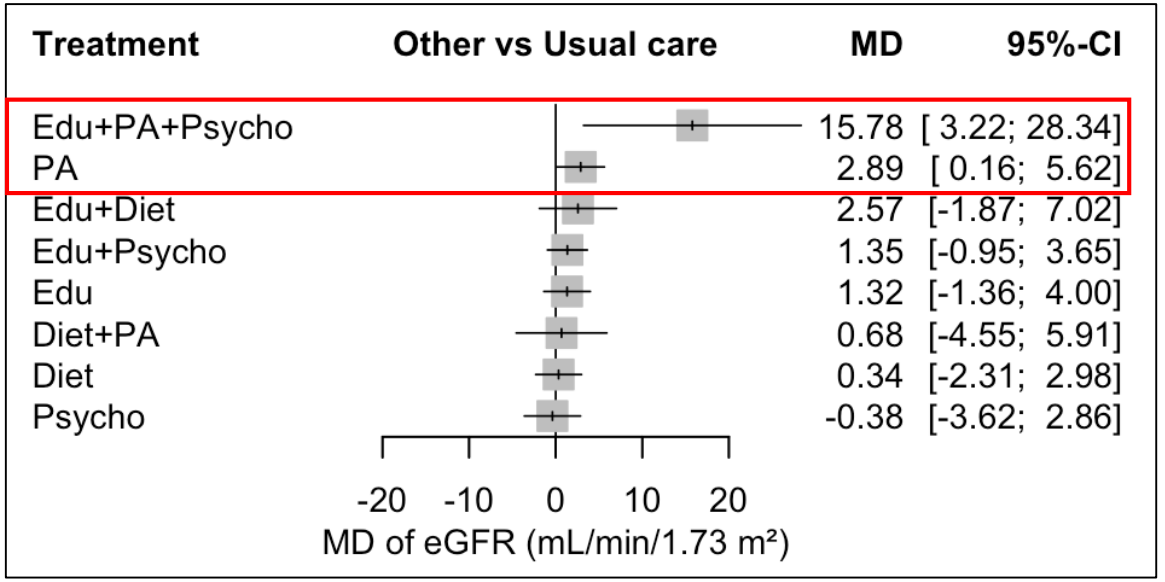


Figure: Forest plot for eGFR outcome (SNMA)

The results of SNMA showed:

- Only **Edu+PA+Psycho** and **PA** significantly improved eGFR compared to **Usual care.**
- Other interventions had no effect on eGFR.
- However, the treatment effect (TE) of **Edu+PA+Psycho** was based on only **one trial** with a very high TE and wide CI.

Difficult to interpret and explain the results (even after 2 – 3 team meetings)

Why CNMA rather than SNMA?

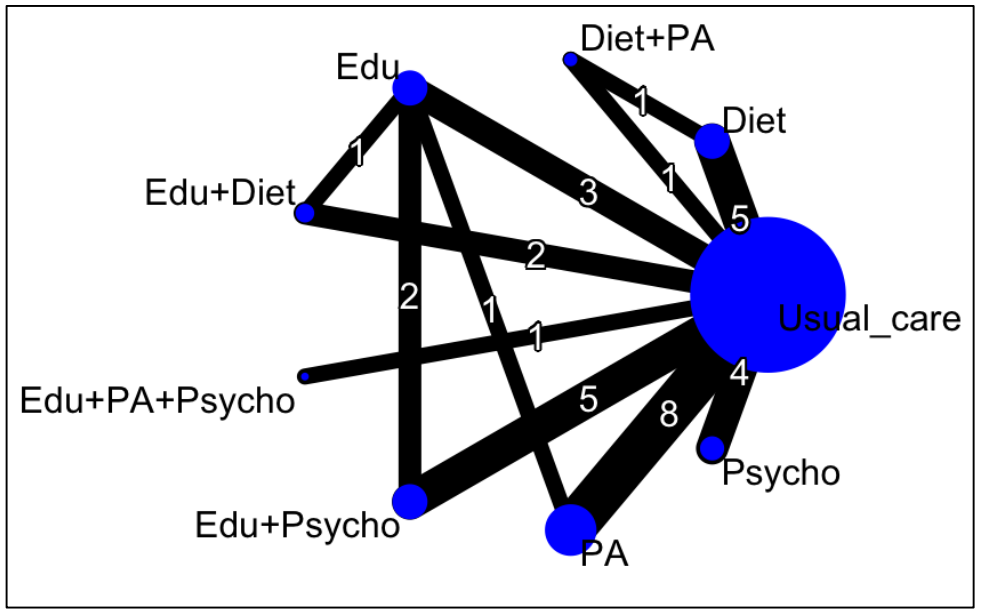


Figure: Network map for eGFR outcome

In addition, this network map also has:

- **8 interventions** + usual care.
  - 4 single interventions:
    - Education (**Edu**)
    - Dietary (**Diet**)
    - Physical activity (**PA**)
    - Psychosocial (**Psycho**)
  - 4 combination interventions:
    - Edu+Diet
    - Diet+PA
    - Edu+Psycho
    - Edu+PA+Psycho

Complex, multicomponent interventions

They shared the common components.

Component network meta-analysis

1. Which components work?
2. Does adding more components increase the treatment effect?

Why CNMA rather than SNMA?

Issues	SNMA	CNMA
Sparse network	- Each node is considered a unique intervention. - Results may reflect those of **single studies** in which the intervention's effect is very strong.	- Unit of analysis: component. - Provides **more precise** estimates of intervention effects by using evidence from **all studies that share the same components**.
Unobserved combinations	- **Cannot** estimate the TE of unobserved combinations.	- **Can** estimate the TE of unobserved combinations.
➔ CNMA is a suitable analytical approach for complex interventions such as SMIs.		

https://doi.org/10.1136/bmjebm-2021-111906

How was the data analysis done in R?

(eGFR outcome)

Model and assumption

- **Model used:** Additive model
- **Assumption**: $\mathbf{d_{SMI\ (combination)} = d_{component\ 1} + d_{component\ 2} (+ \ldots + d_{component\ 4})}$

Components	Treatment effect
Edu	d_{Edu}
Diet	d_{Diet}
PA	d_{PA}
Psycho	d_{Psycho}

Combinations	Treatment effect
Edu+Diet	$= d_{Edu} + d_{Diet}$
Edu+PA	$= d_{Edu} + d_{PA}$
Edu+Psycho	$= d_{Edu} + d_{Psycho}$
Diet+PA	$= d_{Diet} + d_{PA}$
Diet+Psycho	$= d_{Diet} + d_{Psycho}$
PA+Psycho	$= d_{PA} + d_{Psycho}$
Edu+Diet+PA	$= d_{Edu} + d_{Diet} + d_{PA}$
Edu+Diet+Psycho	$= d_{Edu} + d_{Diet} + d_{Psycho}$
Diet+PA+Psycho	$= d_{Diet} + d_{PA} + d_{Psycho}$
Edu+PA+Psycho	$= d_{Edu} + d_{PA} + d_{Psycho}$
Edu+Diet+PA+Psycho	$= d_{Edu} + d_{Diet} + d_{PA} + d_{Psycho}$

d: Treatment effect

Prepare data

- Data can be prepared in long or wide format:
  - **Long format**: One row = one intervention (one study ≥ two rows).
  - Wide format: One row = one study.

study_id	author	year	intervention	n	end_mean	end_sd	mean change	sd change
SMI_039	Hotu	2010	Edu+Psycho	30	33	17	-3	11.47
SMI_039	Hotu	2010	Edu	32	41	18	2	11.92
SMI_018	Chen	2011	Edu+Diet	27	29.11	20.61	1.98	13.65
SMI_018	Chen	2011	Usual_care	27	15.7	10.67	-7.93	8.68
SMI_085	Zuilen	2011	Psycho	395	36.2	16.4	-2.2	11.23
SMI_085	Zuilen	2011	Usual_care	393	35	16.2	-2.7	10.87
SMI_066	Paes-Barreto	2013	Edu+Diet	56	33.7	15.6	1.7	10.43
SMI_066	Paes-Barreto	2013	Usual_care	56	34.1	13.5	0	9.07
SMI_075	Haan	2013	Psycho	99	48.6	8.7	-0.5	5.92
SMI_075	Haan	2013	Usual_care	76	49.4	8	-0.6	5.34
SMI_008	Baria	2014	PA	19	30.16	10.44	2.65	7.25
SMI_008	Baria	2014	Usual_care	10	25.9	14.4	-1.8	10.41
SMI_005	Aoike_2	2015	PA	14	31.9	13.7	3.5	9.16
SMI_005	Aoike_2	2015	Usual_care	14	23.9	12.2	-1.4	9.12
SMI_084	Van Craenenbroeck	2015	PA	25	38.6	14.2	0.74	5.11
SMI_084	Van Craenenbroeck	2015	Usual_care	23	39.2	15.2	-0.33	4.16
SMI_053	Leehey	2016	Diet+PA	18	39.6	19.9	-1.9	13.72
SMI_053	Leehey	2016	Diet	18	35.8	20.2	-3.1	14.32

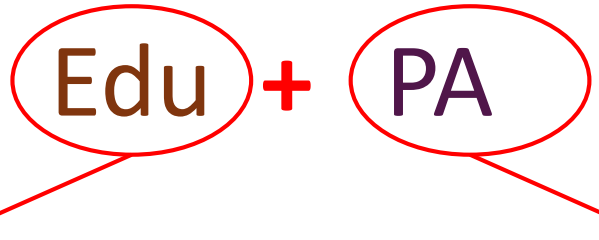
Require information:

- Study ID/author, year
- Intervention/treatment name
- n
- Mean
- SD

Data can be imported into RStudio from various formats, including Excel, Stata, SAS, SPSS, and text.

Prepare data

Make sure that the components within an intervention are connected by “+”!



A combination of two components

Component 1

Component 2

Edu PA

Edu – PA Diet

Edu_PA

Single intervention (one component)

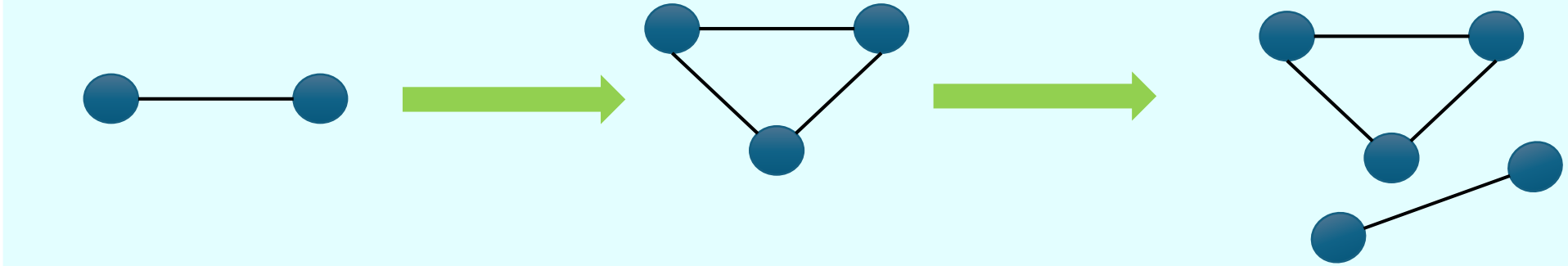
Packages required

- For the **import dataset**:
  - `haven` (for Stata, SPSS, SAS files)
  - `readxl` (for Excel files)
- For **data analysis**:
  - `meta` (draw forest plots from NMA)
  - `netmeta` (for CNMA)
- For **data visualization:**
  - `ggplot2`
  - `grid`
- **Others**: `dplyr` (data manipulation), `stringr`.

Steps of analysis

netmeta

Version: 2025.09.2+418



Pair-wise meta-analysis

Standard network meta-analysis

Component network meta-analysis

Steps of analysis

1. Pair-wise meta-analysis

```
pw_eGFR <- pairwise(studlab = study_id, treat = intervention, n =
n, mean = end_mean, sd = end_sd, data = SMIs_for_CKD_eGFR_End, sm =
"MD", common = FALSE)
```

=> Prepare data for SNMA.

2. Standard network meta-analysis

```
netSMI_eGFR <- netmeta(pw_eGFR, ref = "Usual_care", common = FALSE)
```

Steps of analysis

2. Standard network meta-analysis

```
Treatment estimate (sm = 'MD', comparison: other treatments vs 'Usual_care'):
                    MD            95%-CI     z p-value
Diet           0.3376 [-2.3056;  2.9808]  0.25  0.8023
Diet+PA        0.6766 [-4.5522;  5.9054]  0.25  0.7998
Edu            1.3164 [-1.3632;  3.9960]  0.96  0.3356
Edu+Diet       2.5730 [-1.8709;  7.0168]  1.13  0.2565
Edu+PA+Psycho 15.7800 [ 3.2202; 28.3398]  2.46  0.0138
Edu+Psycho     1.3499 [-0.9519;  3.6517]  1.15  0.2504
PA             2.8916 [ 0.1600;  5.6233]  2.07  0.0380
Psycho        -0.3766 [-3.6154;  2.8623] -0.23  0.8197
Usual_care           .                 .     .       .

Quantifying heterogeneity / inconsistency:
tau^2 = 4.9121; tau = 2.2163; I^2 = 52.8% [26.2%; 69.8%]

Tests of heterogeneity (within designs) and inconsistency (between designs):
                   Q d.f. p-value
Total          52.98   25  0.0009
Within designs 40.14   19  0.0031
Between designs 12.84    6  0.0457
```

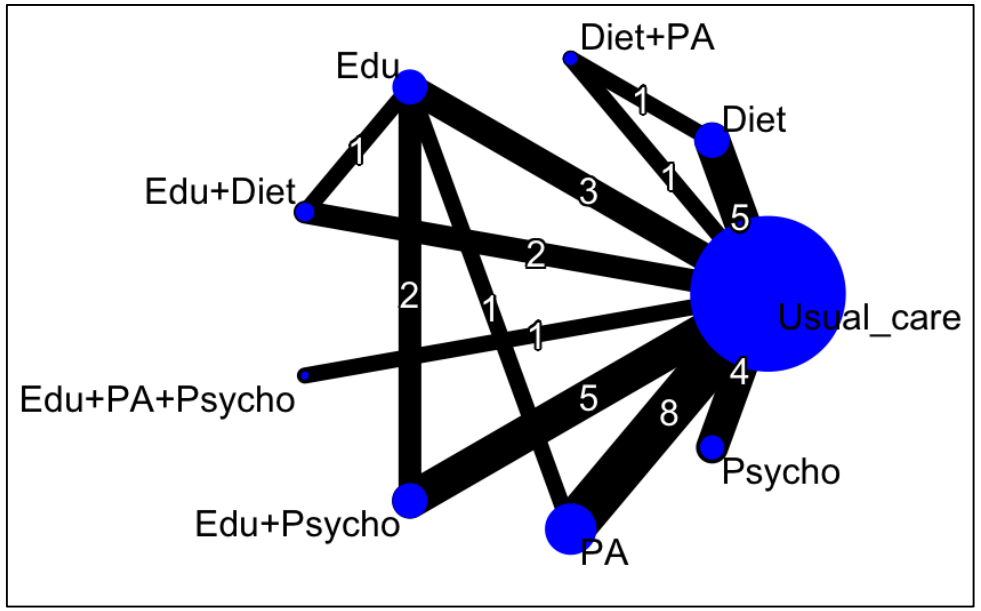


Figure: Network map for eGFR outcome

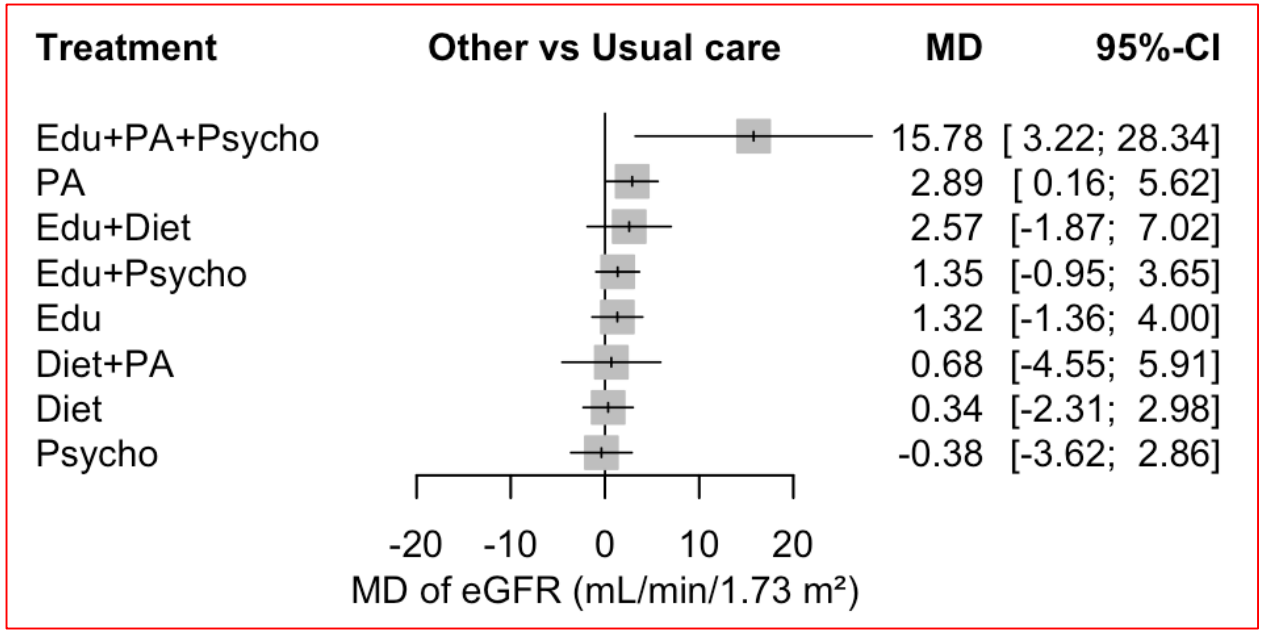


Figure: Forest plot for eGFR outcome (**SNMA**)

Steps of analysis

3. Component network meta-analysis

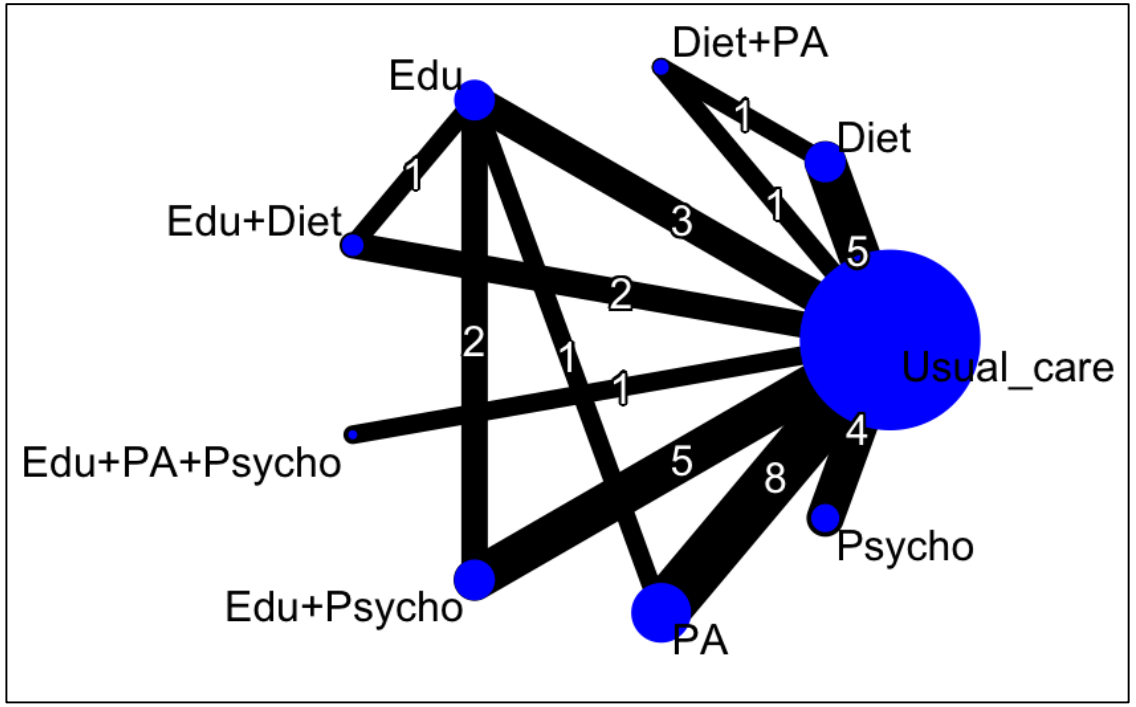


Figure: Network map for eGFR outcome

- Connected network => `netcomb`

```
cnma_eGFR <- netcomb(netSMI_eGFR, inactive = "Usual_care", component = TRUE, add=FALSE)
```

```
Incremental effect for existing combinations:
                  iMD            95%-CI    z p-value
Diet+PA       2.9919 [ 0.1424; 5.8414] 2.06  0.0396
Edu+Diet      1.8422 [-0.9229; 4.6073] 1.31  0.1916
Edu+PA+Psycho 4.4365 [ 1.2748; 7.5982] 2.75  0.0060
Edu+Psycho    1.6308 [-0.3732; 3.6348] 1.59  0.1107

Incremental effect for components:
           iMD            95%-CI     z p-value
Diet    0.1862 [-1.9064; 2.2788]  0.17  0.8616
Edu     1.6560 [-0.5288; 3.8408]  1.49  0.1374
PA      2.8057 [ 0.4608; 5.1506]  2.35  0.0190
Psycho -0.0252 [-2.1351; 2.0847] -0.02  0.9813

Quantifying heterogeneity / inconsistency:
tau^2 = 4.3121; tau = 2.0766; I^2 = 51.9% [26.9%; 68.3%]

Heterogeneity statistics:
                     Q df p-value
Additive model   60.27 29  0.0006
Standard model   52.98 25  0.0009
Difference        7.29  4  0.1214
```

Steps of analysis

3. Component network meta-analysis

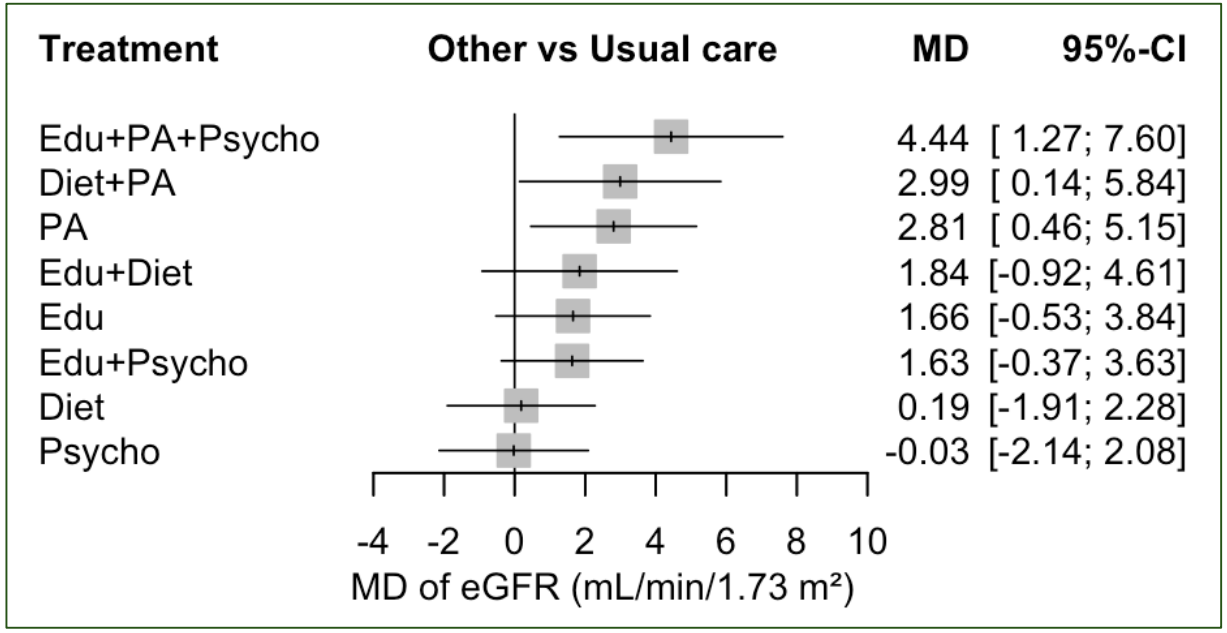


Figure: Forest plot for eGFR outcome (**CNMA**)

Results of observed monocomponents and combinations (8 out of 15 interventions).

3. Component network meta-analysis

Interventions	Observed from trials?
Edu	☑
Diet	☑
PA	☑
Psycho	☑
Edu+Diet	☑
Edu+PA	✗
Edu+Psycho	☑
Diet+PA	☑
Diet+Psycho	✗
PA+Psycho	✗
Edu+Diet+PA	✗
Edu+Diet+Psycho	✗
Diet+PA+Psycho	✗
Edu+PA+Psycho	☑
Edu+Diet+PA+Psycho	✗

Identify unobserved combinations

```
unobserved_comb_name <- c("Diet+Psycho",
"Edu+PA", "PA+Psycho", "Edu+Diet+PA",
"Edu+Diet+Psycho", "Diet+PA+Psycho",
"Edu+Diet+PA+Psycho")
```

Estimate TEs of unobserved combinations

```
cnma_unobserved_eGFRend <-
netcomplex(cnma_eGFR, unobserved_comb_name)
```

Combine the results of observed and unobserved interventions.

Steps of analysis

3. Component network meta-analysis

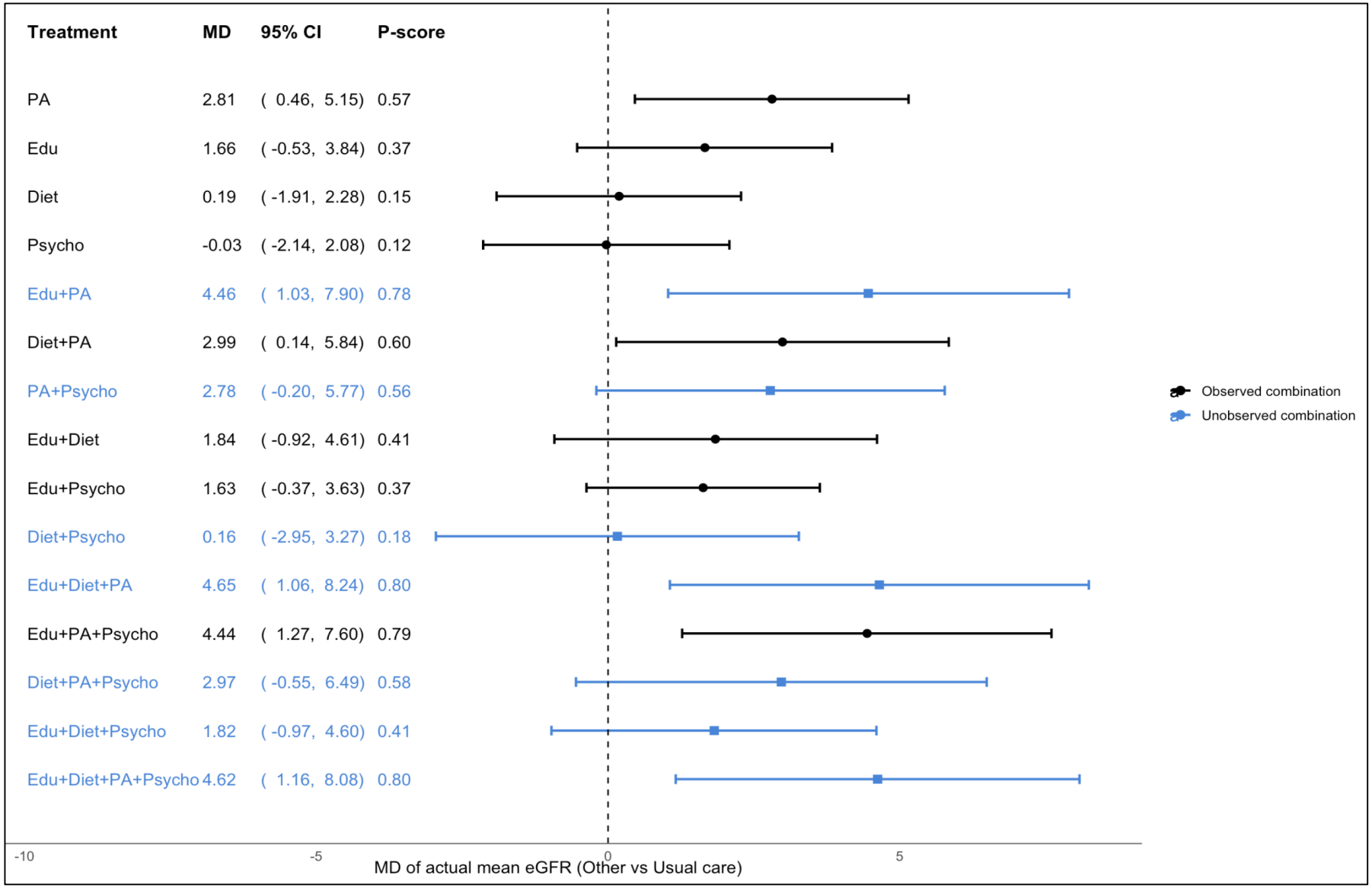


Figure: Forest plot of all interventions for eGFR outcome (**CNMA**)

How to interpret the results?

Interpret the results

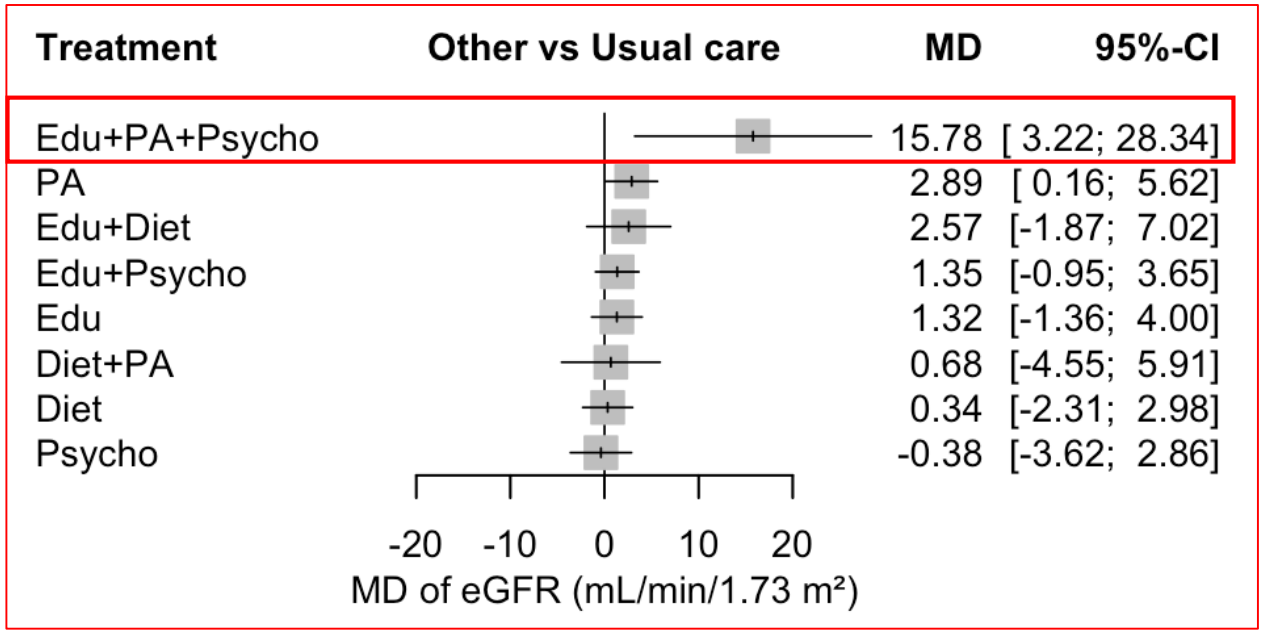


Figure: Forest plot for eGFR outcome (**SNMA**)

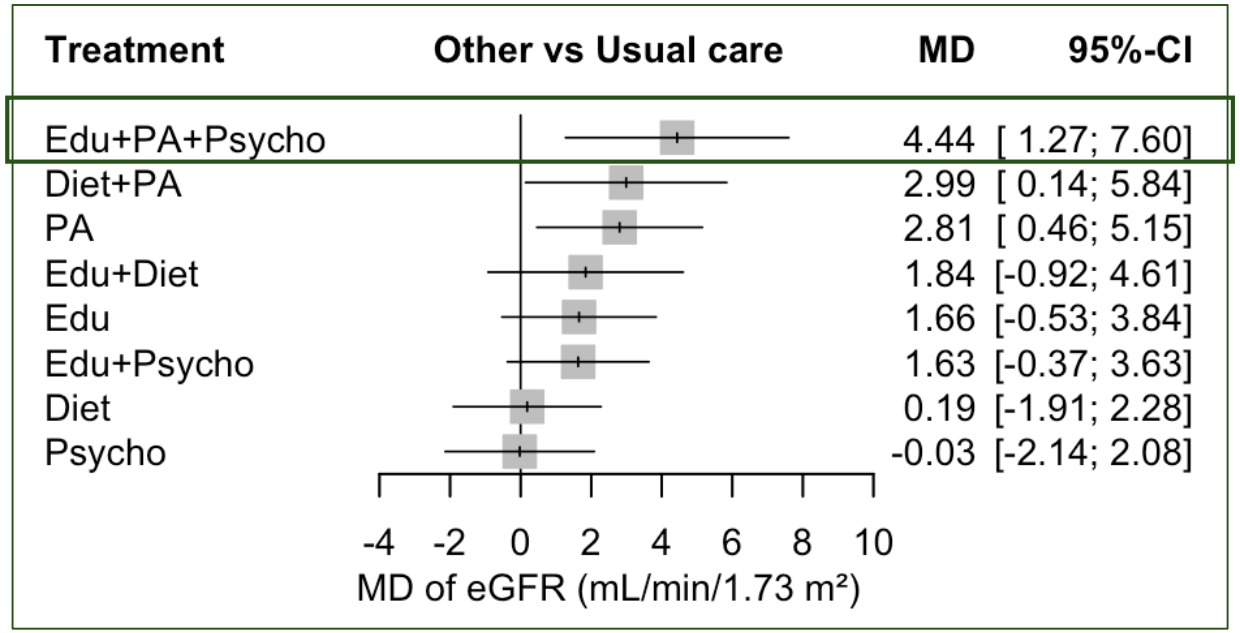


Figure: Forest plot for eGFR outcome (**CNMA**)

- TE of Edu+PA+Psycho **reduced** from 15.78 (SNMA) to 4.44 (CNMA) with a **narrower 95% CI** (1.27; 7.60).
- The CIs from CNMA were narrower than those from SNMA.
- In addition to Edu+PA+Psycho and PA, CNMA showed that Diet+PA significantly improved eGFR compared with Usual care.

➔ CNMA provided **more precise** and **explainable** results

Interpret the results

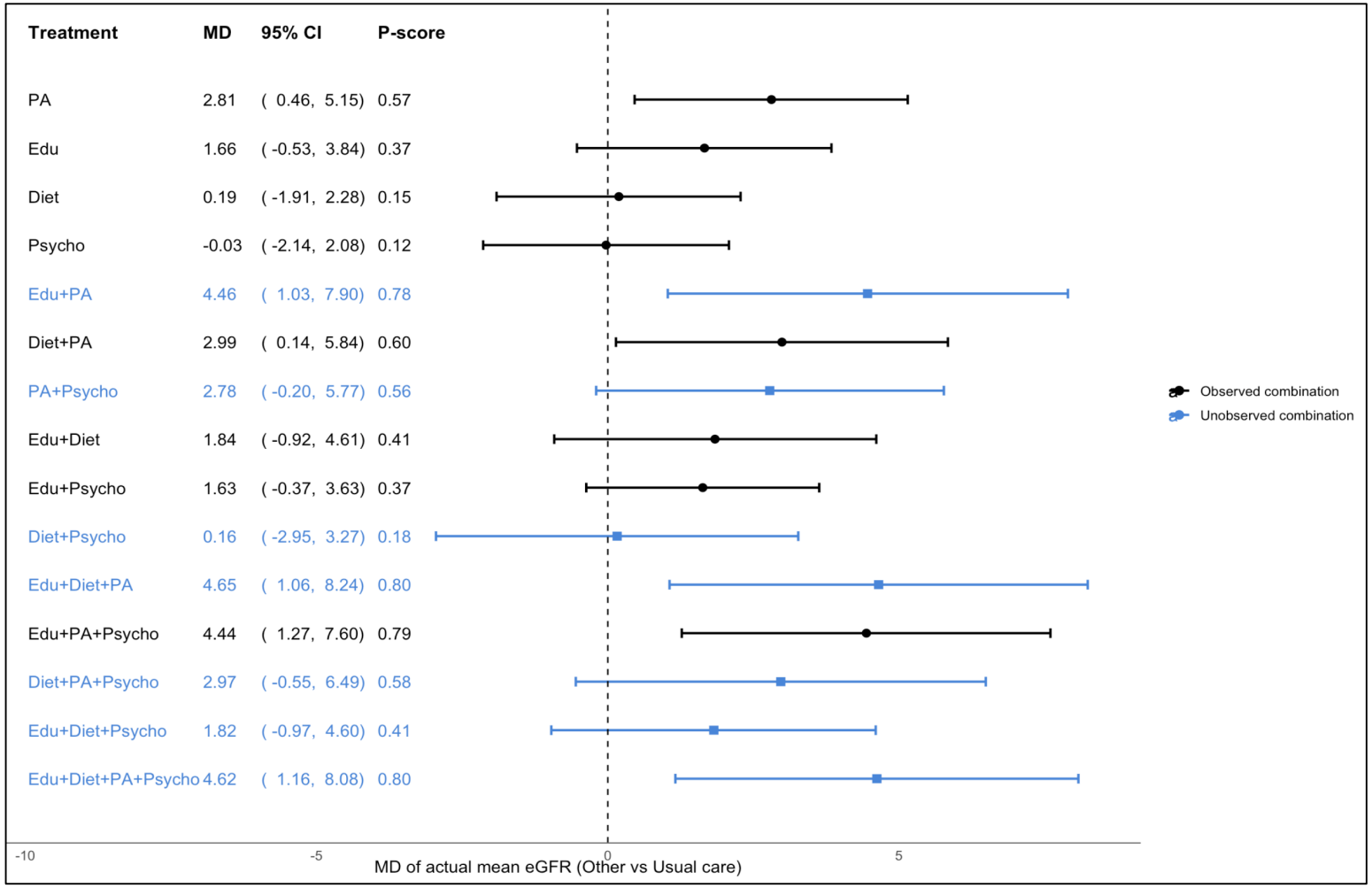


Figure: Forest plot of all SMIs for eGFR outcome (**CNMA**)

- **PA** was the only mono-component SMI that **significantly improved eGFR**.

Among two-component SMIs:

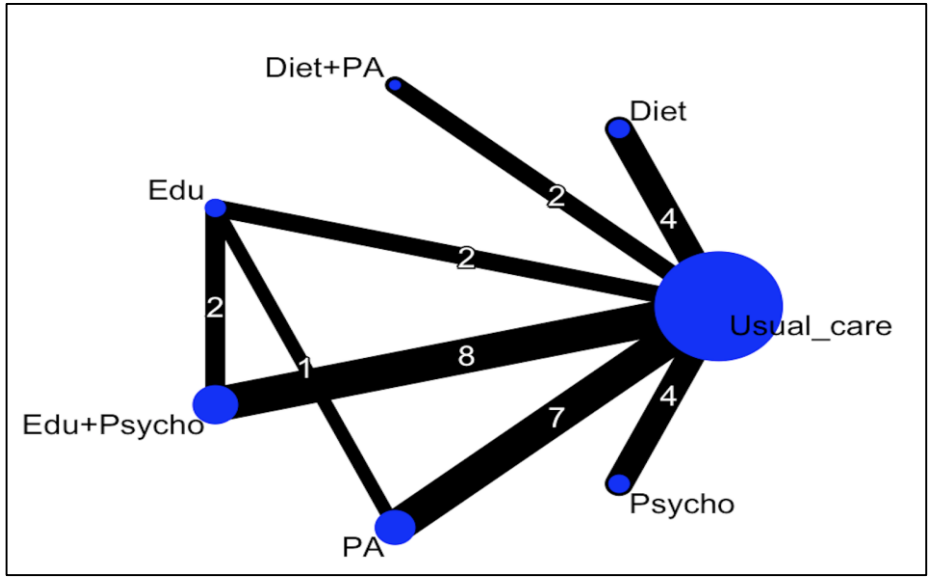
- Adding **Edu** and **Diet** to PA increased the TE compared with Edu+PA alone.

Among three-component SMIs:

- Adding **Diet** to **Edu+PA** also increased the TE compared with Edu+PA alone.
- Adding **Psycho** to Edu+PA and Edu+Diet+PA **did not yield any additional effect**.

Additional outcomes

Systolic blood pressure (SBP)



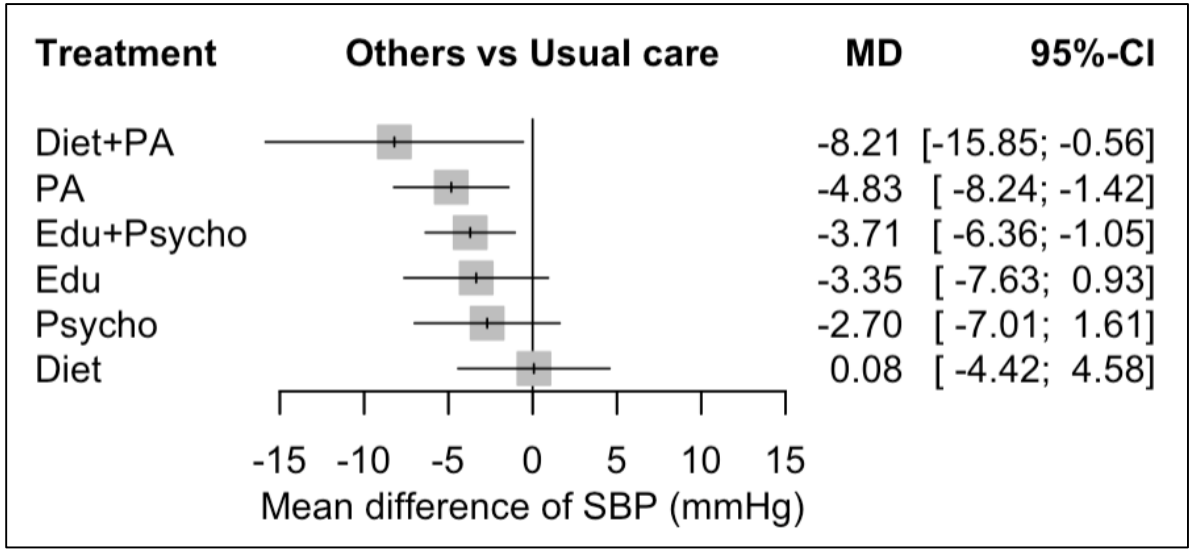


Figure: Forest plot for SBP outcome (**SNMA**)

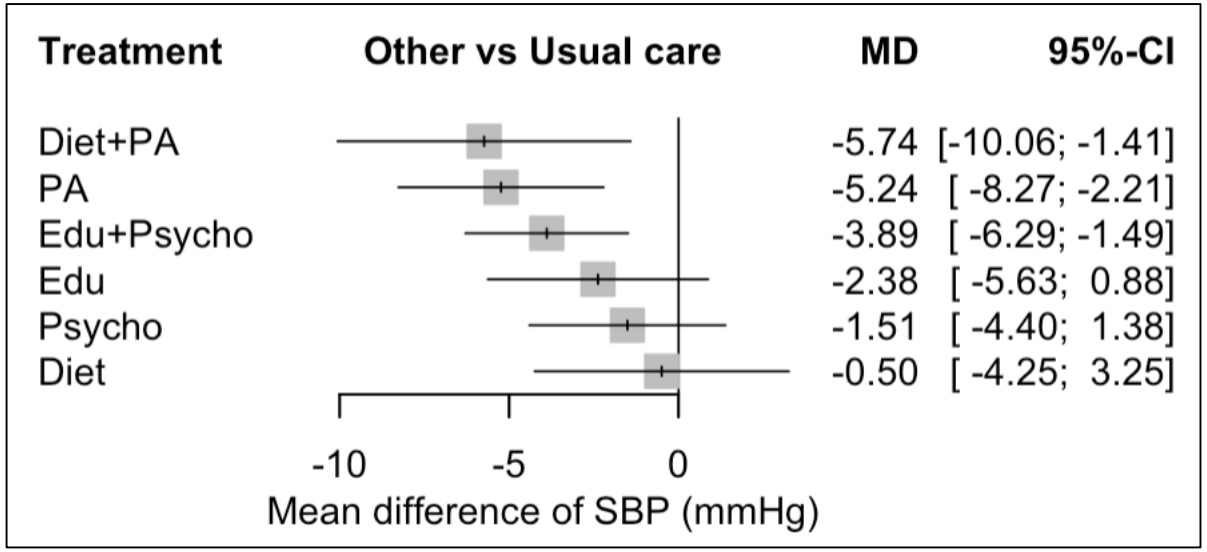


Figure: Forest plot for SBP outcome (**CNMA**)

Systolic blood pressure (SBP)

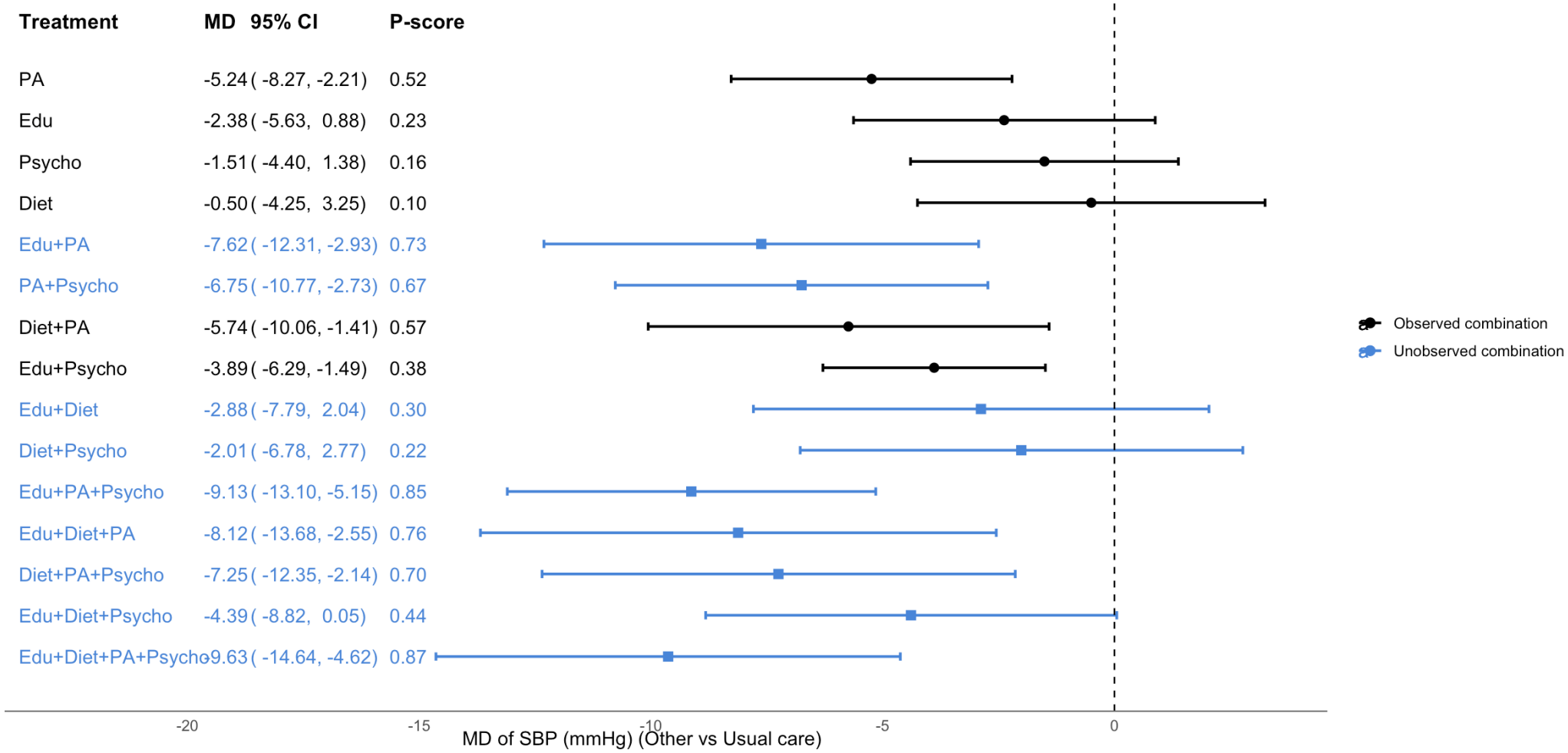
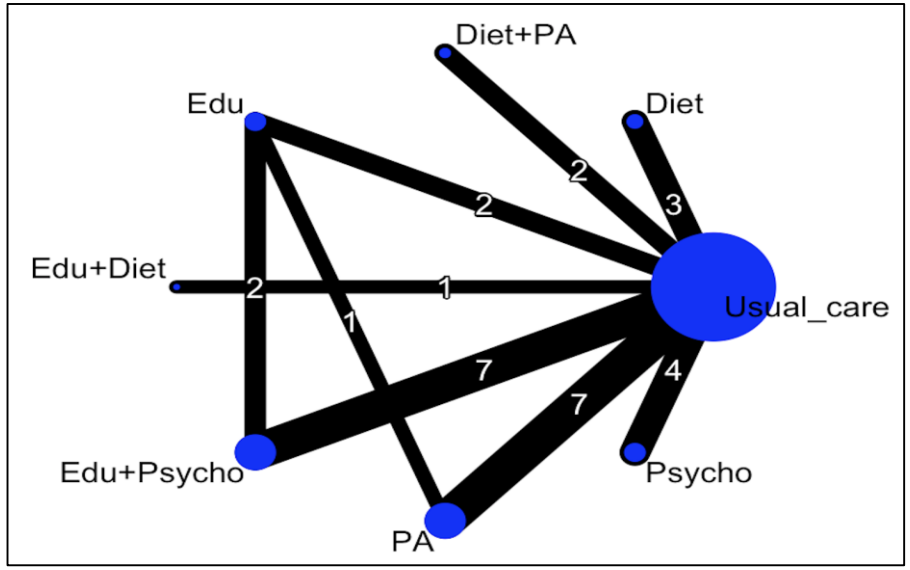


Figure: Forest plot of all SMIs for SBP outcome (**CNMA**)

Diastolic blood pressure (DBP)



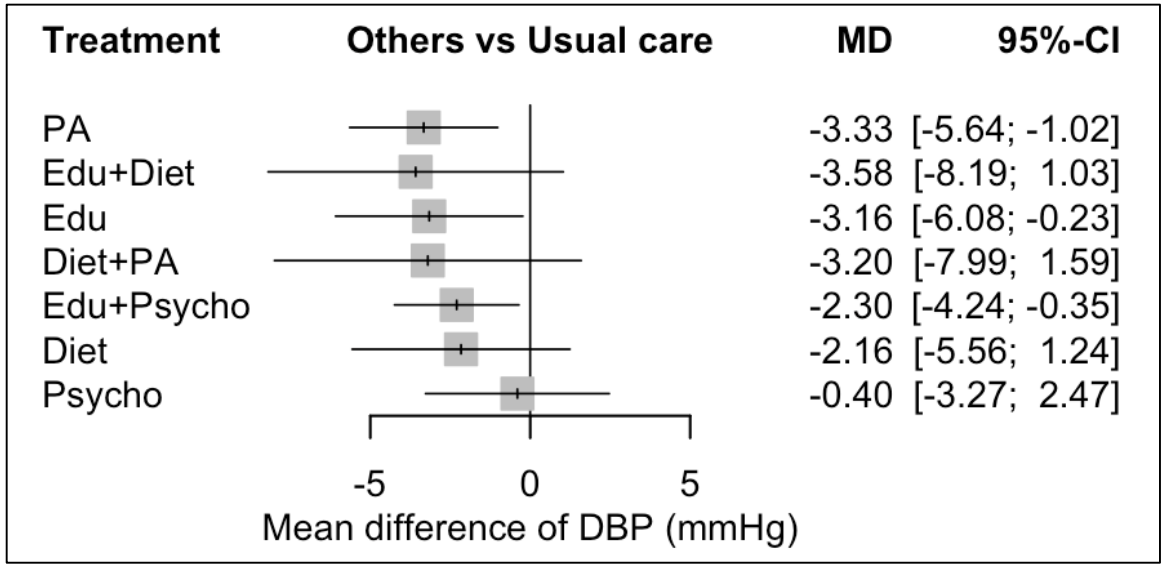


Figure: Forest plot for DBP outcome (**SNMA**)

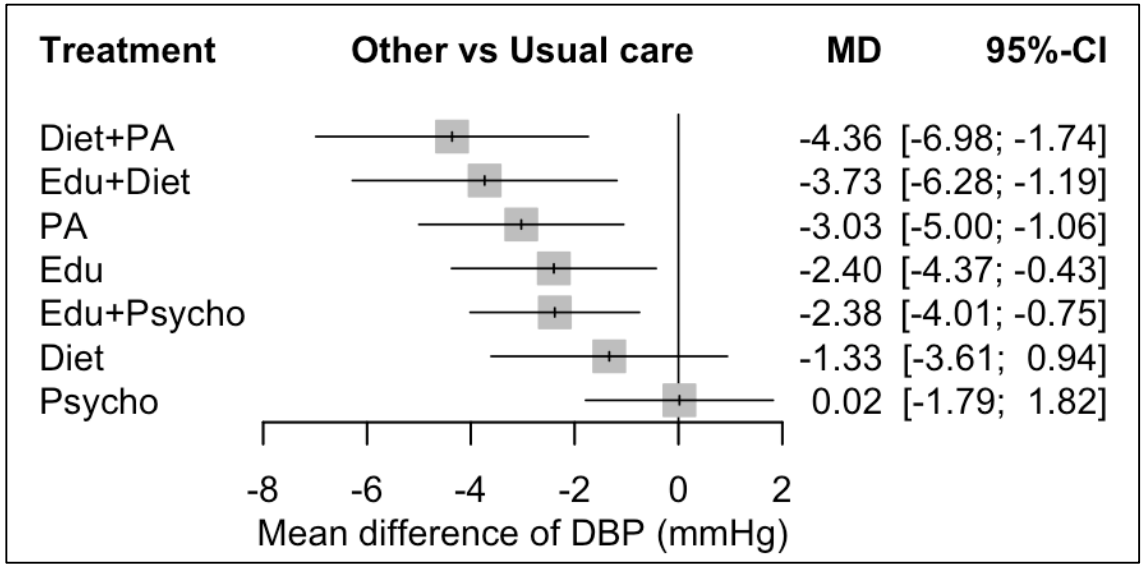


Figure: Forest plot for DBP outcome (**CNMA**)

Diastolic blood pressure (DBP)

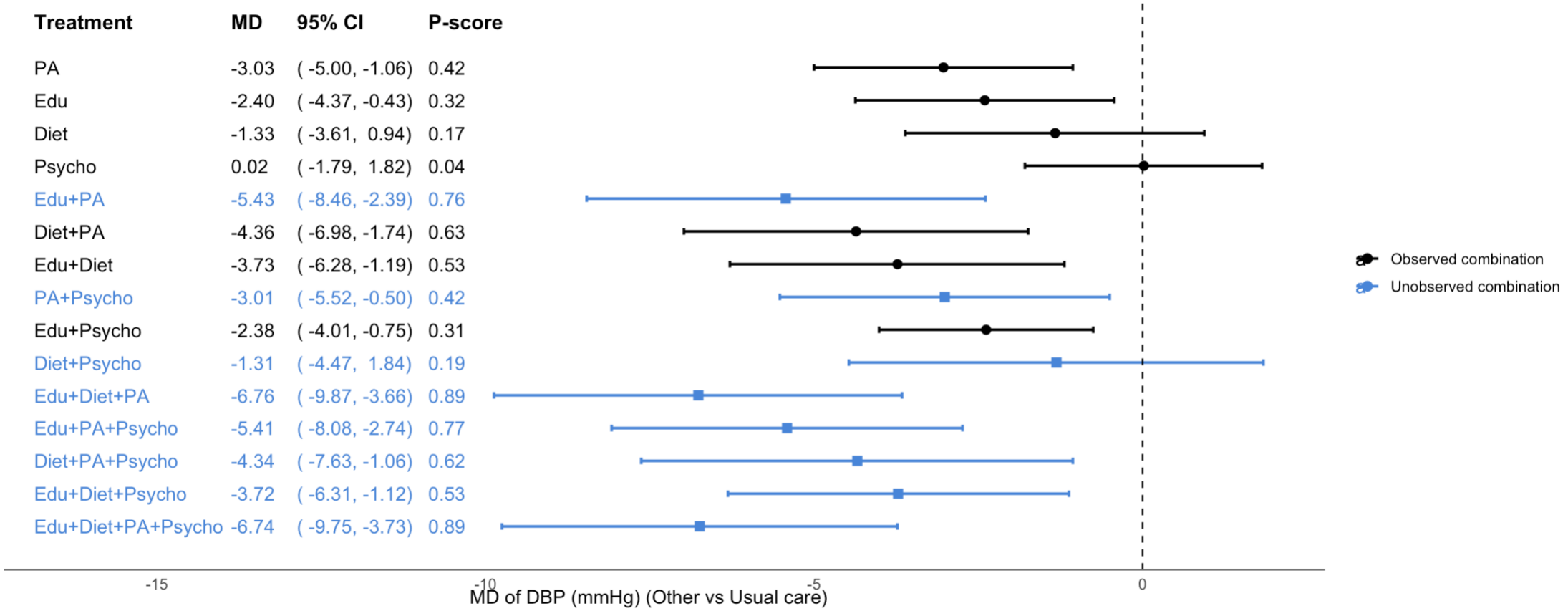


Figure: Forest plot of all SMIs for DBP outcome (**CNMA**)

Checking addictive assumption

Outcomes	Q (df) (Heterogeneity statistics)		
	CNMA (Additive model)	SNMA (Standard model)	Difference
eGFR	60.27 (29)	52.98 (25)	7.29 (4) p = 0.1214
SBP	58.54 (25)	55.99 (23)	2.56 (2) p = 0.2783
DBP	70.68 (24)	62.20 (21)	8.47 (3) p = 0.0372

For more information

1. Tsokani S, Seitidis G, Mavridis D. Component network meta-analysis in a nutshell. BMJ Evid Based Med. 2023 Jun;28(3):183-186. doi: 10.1136/bmjebm-2021-111906. Epub 2022 Jul 27. PMID: 35896417.
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Thank you for your attention!

Discussion