Supplementary Information

Nutrition Journal

Association of sugar intake from different sources with incident dementia in the prospective cohort of UK Biobank participants

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Additional File 1: Figures

Figure S1

Sugar sources relevant to the present study.

Figure S2

Flowchart of participant selection

Figure S3

Venn diagram depicting number of participants excluded by seven exclusion criteria: 1) missing lifestyle risk factors (physical activity or smoking status), 2) diagnosis of all-cause dementia before completion of the last Oxford WebQ, 3) missing socioeconomic factors (Townsend deprivation index, total household income, ethnic background, highest qualification, or overall health rating), 4) missing data of the physical exam (body mass index (BMI), systolic blood pressure (SBP)), 5) pre-existing malabsorption, 6) history of diabetes mellitus, and 7) implausible energy or carbohydrate intake, i.e., 0 kJ/d intake on at least one occasion, being in the upper 0.1 % of total energy and/or carbohydrate consumption or total energy intake <1.1 × basal metabolic rate - 500 kcal (under-reporting) or >2.5 × basal metabolic rate + 500 kcal (over-reporting) resulting in a study population of 186,622 participants.

Figure S4

Landmark analysis

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (landmark analysis; n=186,580; number of cases=1,456). Models are adjusted for energy intake, age, alcohol intake, BMI, ethnic background, general health status, highest qualification, history of mental illnesses, physical activity, SBP, sex, smoking status, total household income, and Townsend deprivation index. Covariates not fulfilling the proportional hazard assumption are stratified. The nadir is indicated by the vertical line. *Abbreviations*: *BMI* Body mass index, *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy, *SBP* Systolic blood pressure

Figure S5

Unintentional weight loss removed

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (unintentional weight loss removed; n=157,057; number of cases=1,223). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S6

Participants with history of CVD and cancer removed

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (participants with history of CVD and cancer removed; n=164,855; number of cases=1,180). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S7

Participants with only one completed Oxford WebQ removed

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (participants with only one completed Oxford WebQ removed; n=115,480; number of cases=776). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S8

Non-typical diet removed

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (non-typical diet removed; n=125,313; number of cases=1,185). Models are adjusted and presented as

indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S9

Special diet removed

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (special diet removed; n=160,752; number of cases=1,274). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S10

Restricted to participants with age ≥ 60 years

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (restricted to participants with age ≥ 60 years; n=90,571; number of cases=1,361). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S11

Stratified by age (< 60 and ≥ 60 years)

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (models were further stratified by age; n=186,622; number of cases=1,498). Models are adjusted and presented as indicated in Additional file 1 Fig. S4 except for the age covariate being replaced by a strata of age </≥ 60 years. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S12

First Oxford WebQ only

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (only the first Oxford WebQ was used for intake estimation; n=186,622; number of cases=1,498). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S13

Adjustment for diet quality score

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (models were further adjusted for diet quality score; n=184,271; number of cases=1,457). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S14

Adjustment for WHR and height instead of BMI

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (models were adjusted for WHR and height instead of BMI; n=186,580; number of cases=1,498). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S15

Missing values of covariates recoded as “unknown” category

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (missing values of covariates recoded as “unknown” category; n=190,205; number of cases=1,546). Models are

adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

Figure S16

Only minimal set of exclusion criteria applied

Association of **a** FS, **b** intrinsic sugars, as well as FS in **c** beverages, **d** solids, **e** soda/fruit drinks, **f** juice, **g** milk-based drinks, **h** tea/coffee, **i** treats, **j** cereals, **k** toppings, and **l** sauces (all %E) with dementia risk (only minimal set of exclusion criteria applied; n=210,821; number of cases=1,859). Models are adjusted and presented as indicated in Additional file 1 Fig. S4. *Abbreviations*: *FS* Free sugars, *HR* Hazard ratio, *%E* Percentage total energy

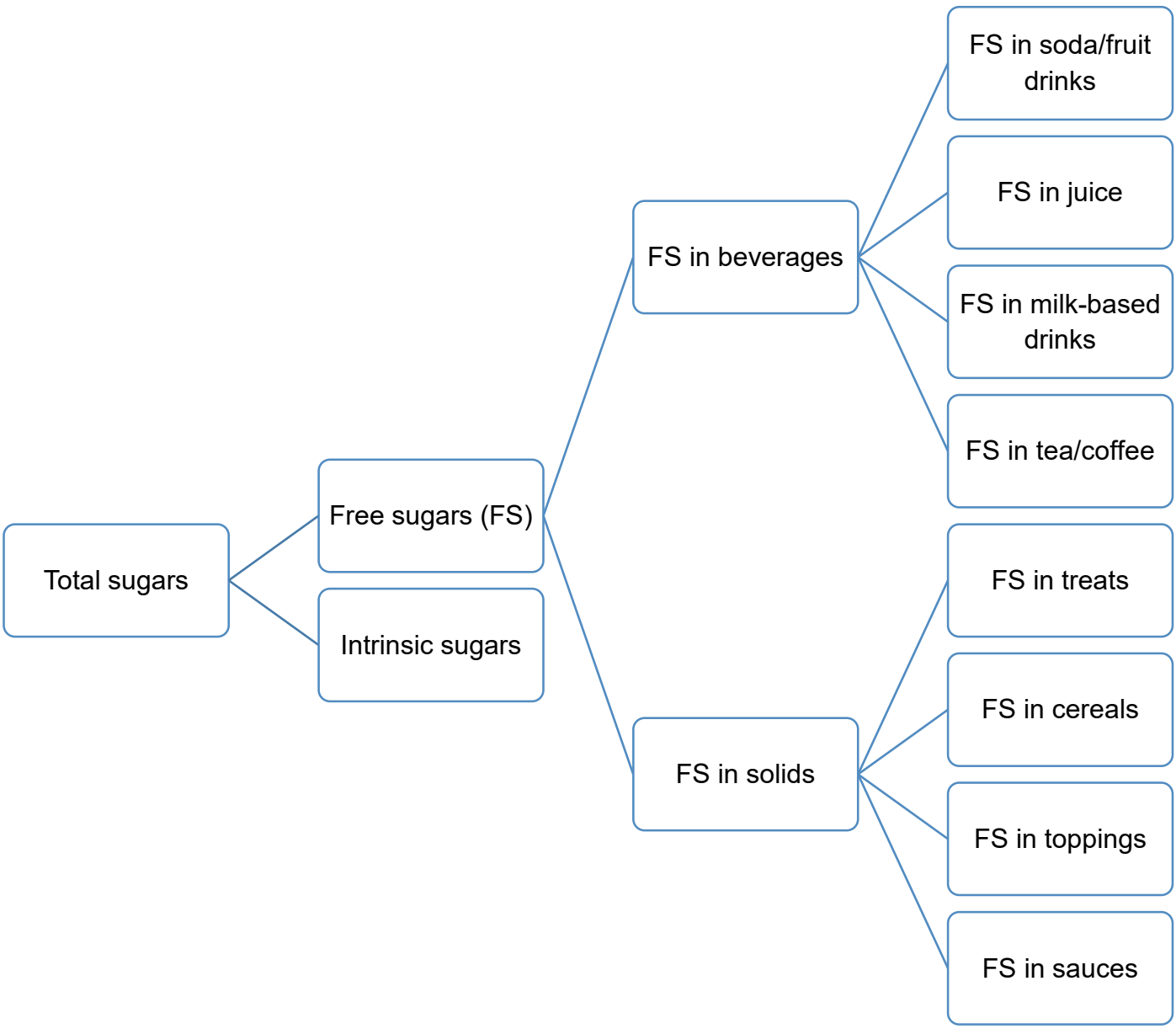

Total sugars
Free sugars (FS)
Intrinsic sugars
FS in beverages
FS in solids
FS in soda/fruit drinks
FS in juice
FS in milk-based drinks
FS in tea/coffee
FS in treats
FS in cereals
FS in toppings
FS in sauces

Figure S1

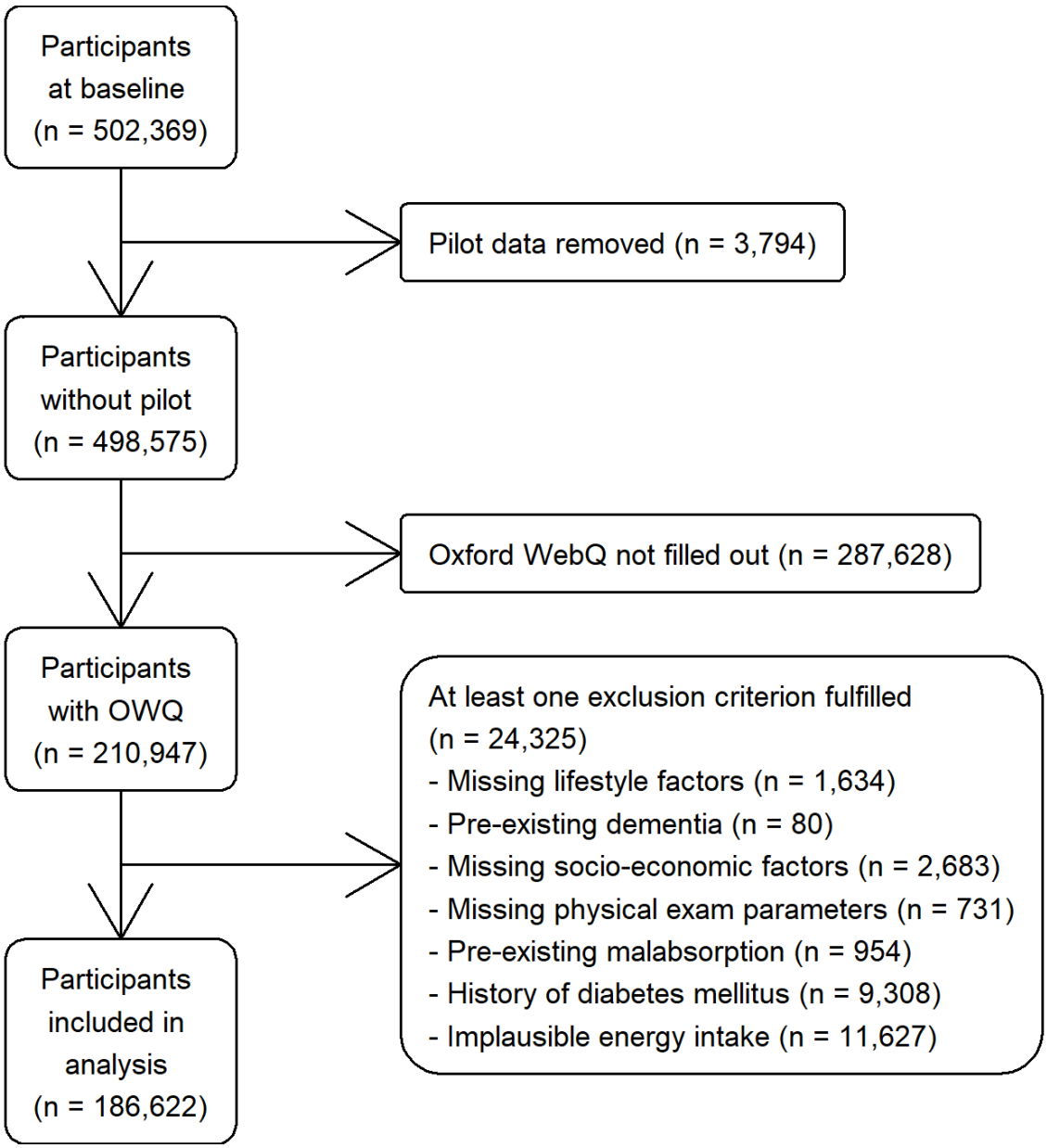

Participants at baseline (n = 502,369)
Pilot data removed (n = 3,794)
Participants without pilot (n = 498,575)
Oxford WebQ not filled out (n = 287,628)
Participants with OWQ (n = 210,947)
At least one exclusion criterion fulfilled (n = 24,325)
- Missing lifestyle factors (n = 1,634)
- Pre-existing dementia (n = 80)
- Missing socio-economic factors (n = 2,683)
- Missing physical exam parameters (n = 731)
- Pre-existing malabsorption (n = 954)
- History of diabetes mellitus (n = 9,308)
- Implausible energy intake (n = 11,627)
Participants included in analysis (n = 186,622)

Figure S2

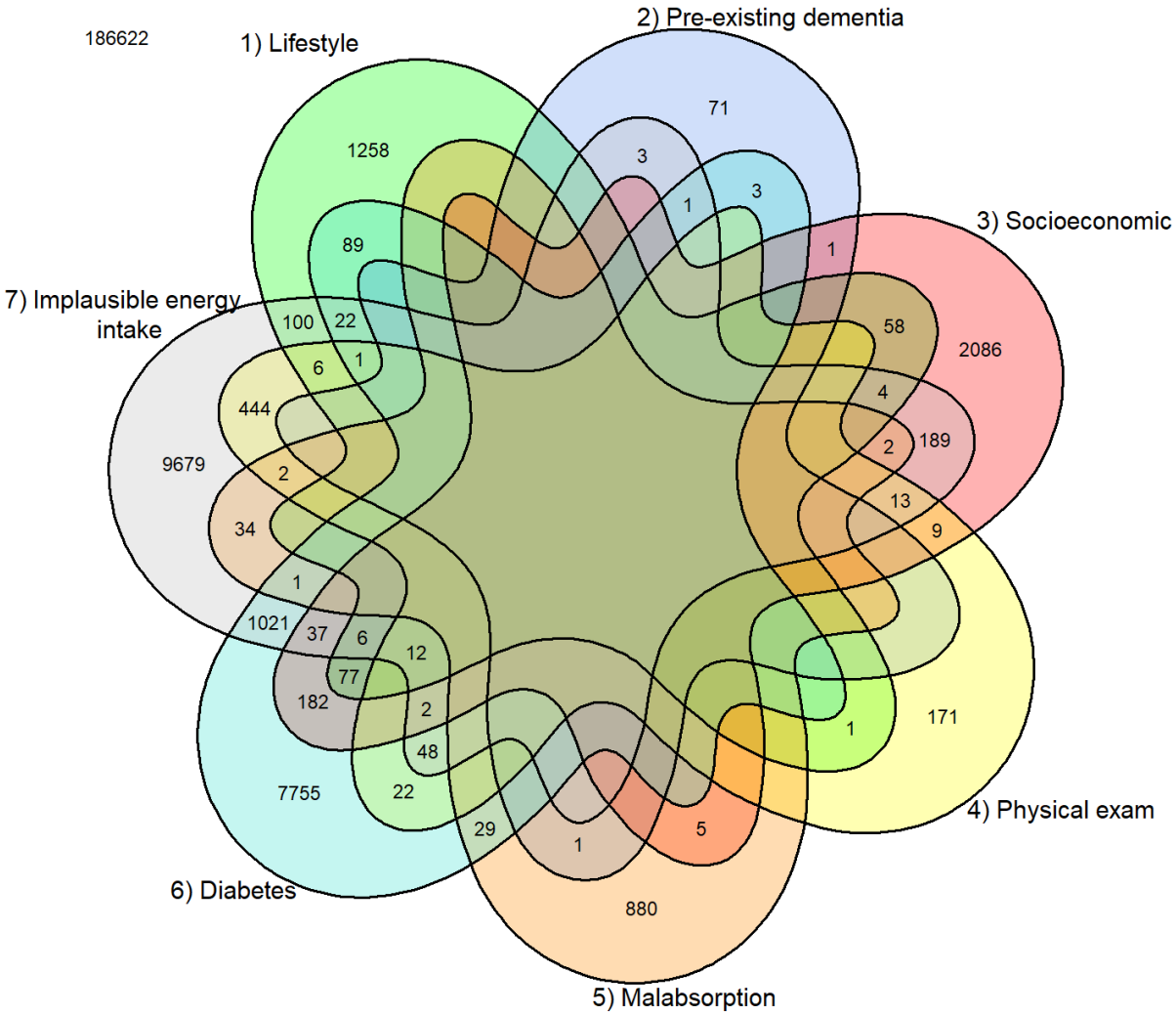
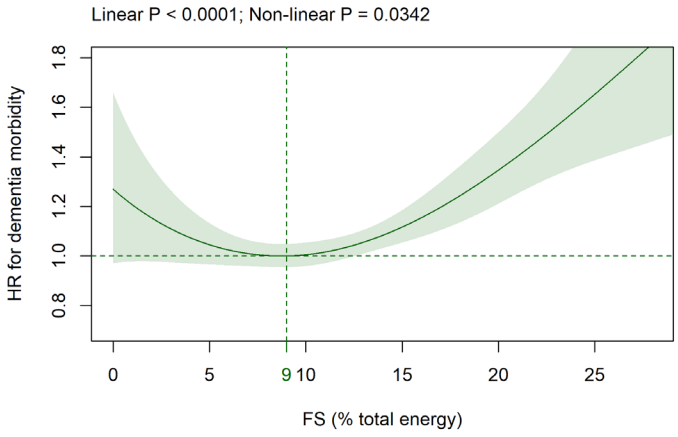

186622
1) Lifestyle
2) Pre-existing dementia
3) Socioeconomic
4) Physical exam
5) Malabsorption
6) Diabetes
7) Implausible energy intake
1258
71
3
1
3
89
1
100
22
6
1
58
2086
444
4
2
189
9679
2
13
34
9
1
1021
37
6
12
77
182
2
48
171
1
7755
22
29
1
5
880

Figure S3

(a)



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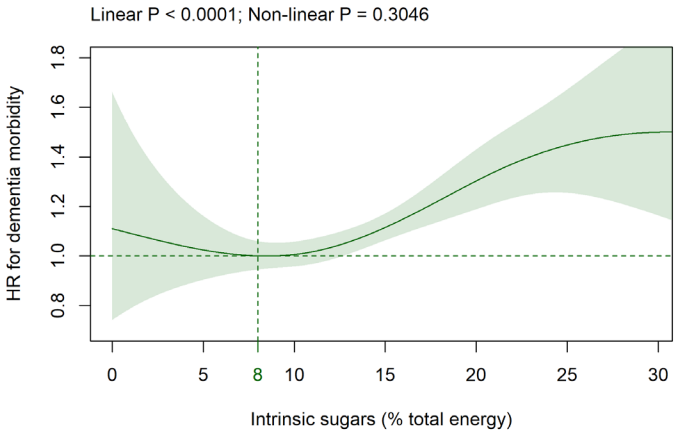

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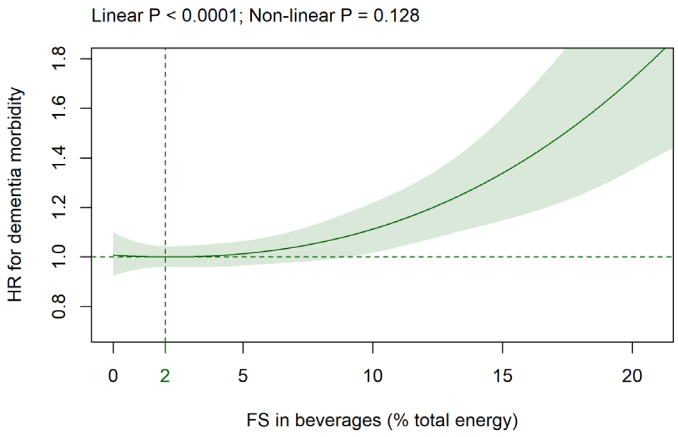

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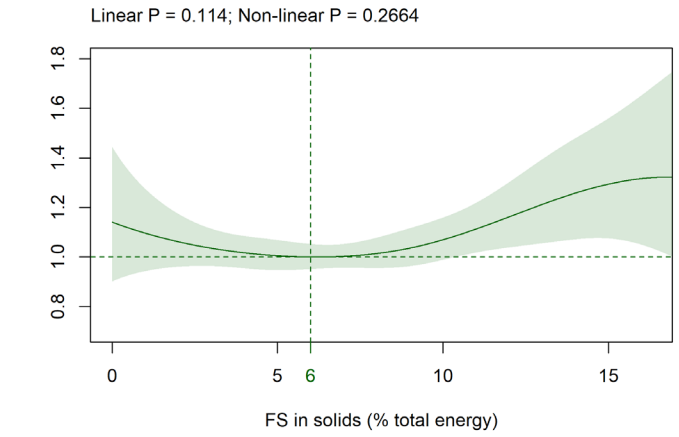


Figure S4

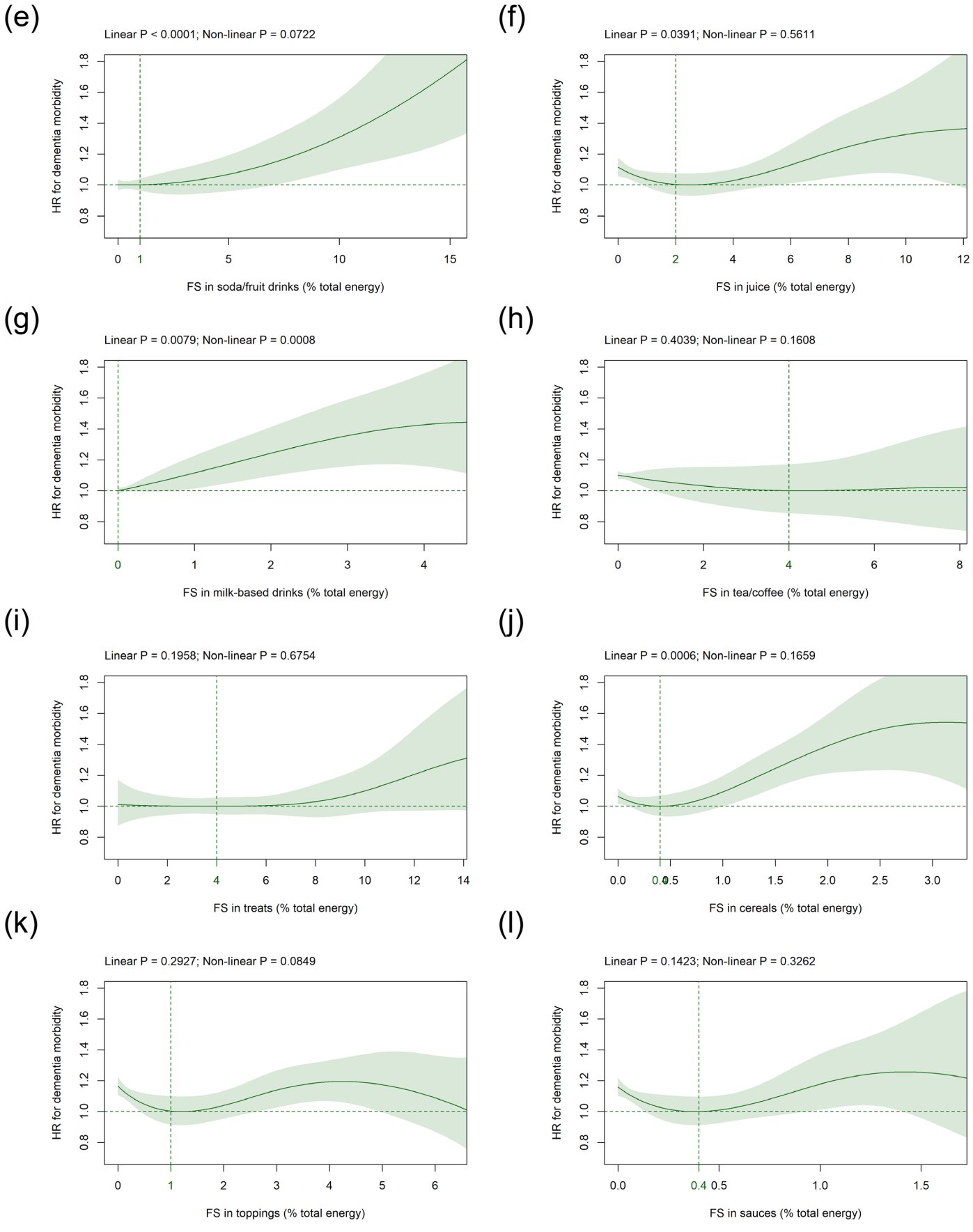


Figure S4 continued

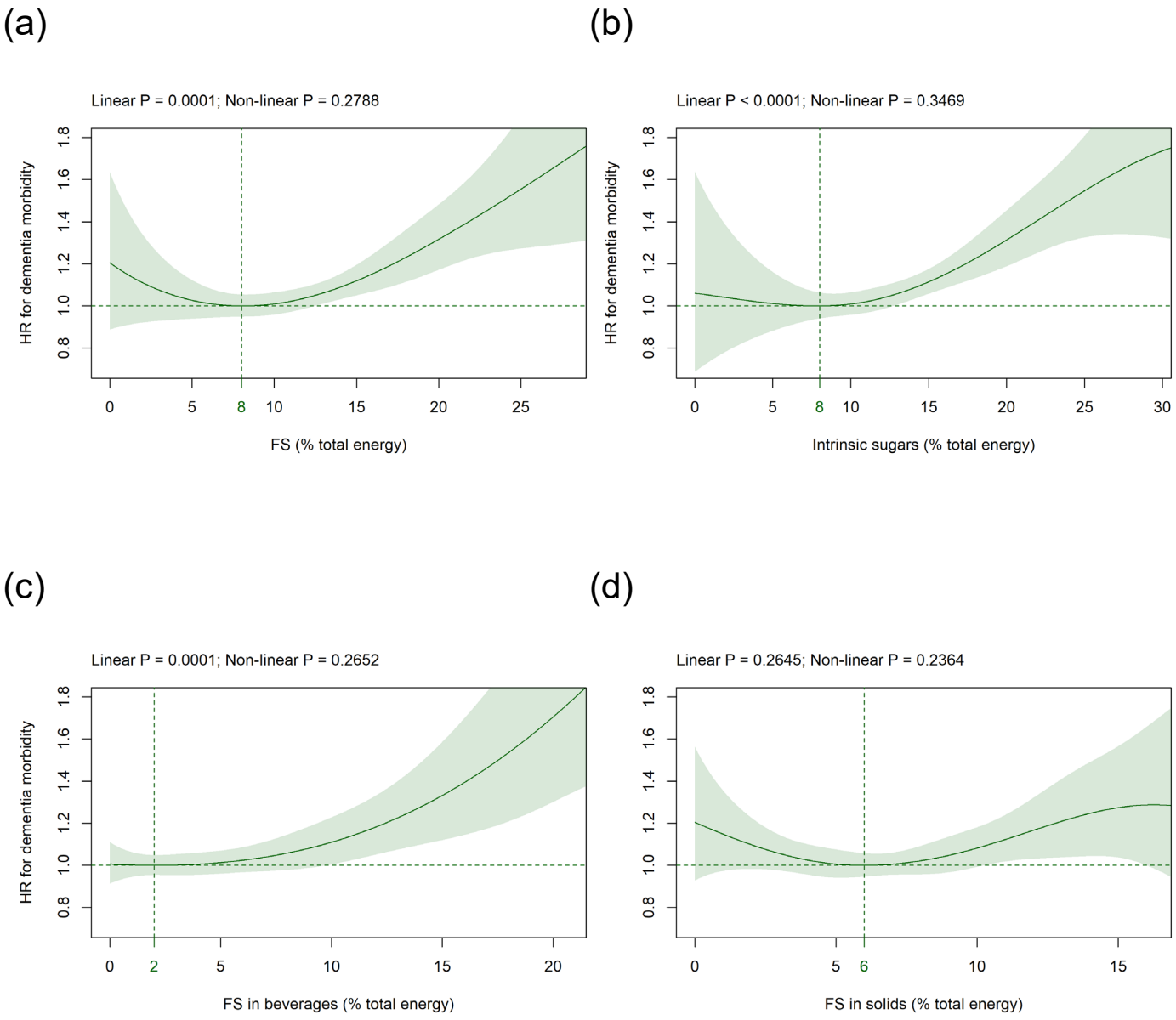

(a)
Linear P = 0.0001; Non-linear P = 0.2788
HR for dementia morbidity
0.8
1.0
1.2
1.4
1.6
1.8
0
5
8
10
15
20
25
FS (% total energy)
(b)
Linear P < 0.0001; Non-linear P = 0.3469
HR for dementia morbidity
0.8
1.0
1.2
1.4
1.6
1.8
0
5
8
10
15
20
25
30
Intrinsic sugars (% total energy)
(c)
Linear P = 0.0001; Non-linear P = 0.2652
HR for dementia morbidity
0.8
1.0
1.2
1.4
1.6
1.8
0
2
5
10
15
20
FS in beverages (% total energy)
(d)
Linear P = 0.2645; Non-linear P = 0.2364
0.8
1.0
1.2
1.4
1.6
1.8
0
5
6
10
15
FS in solids (% total energy)

Figure S5

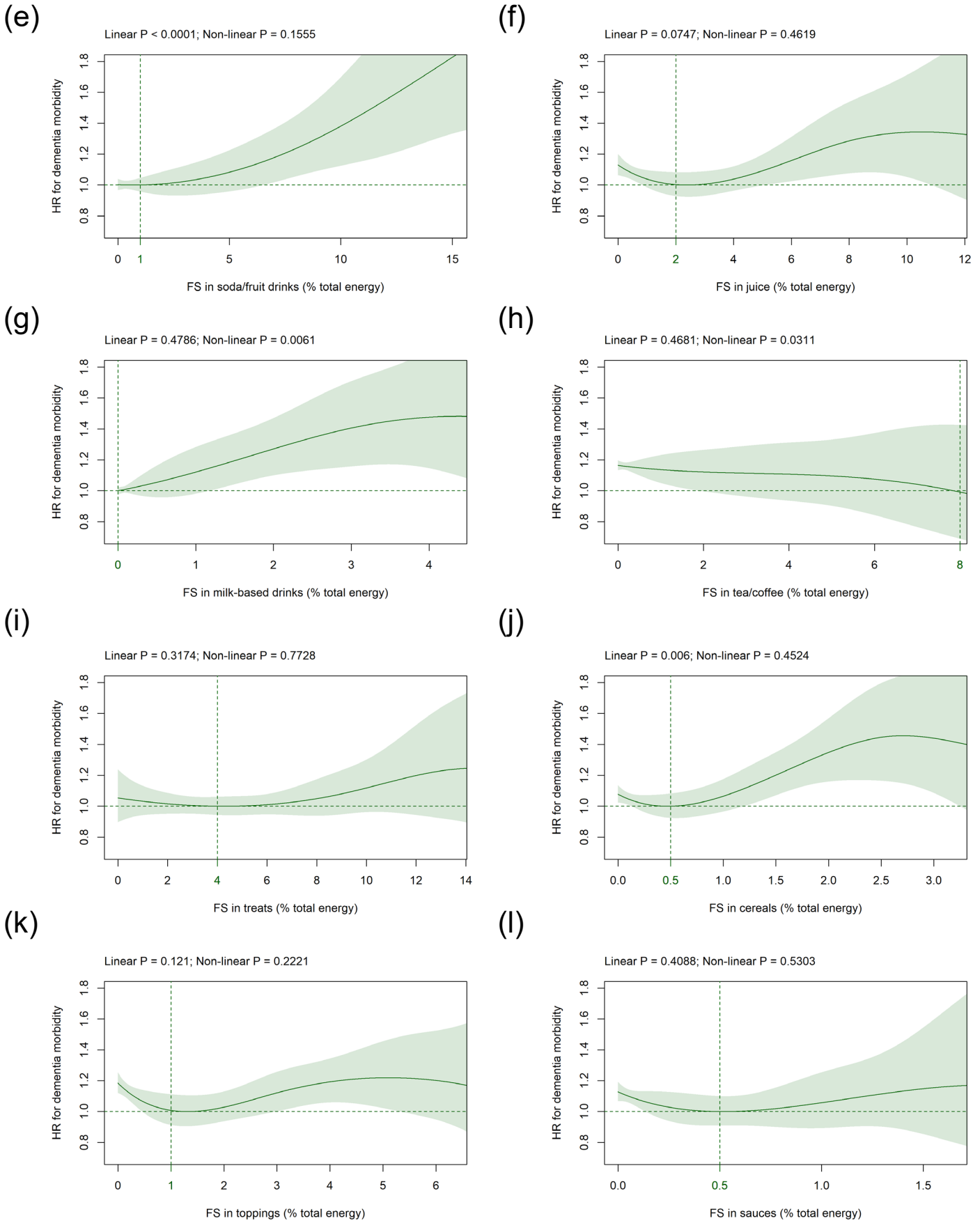
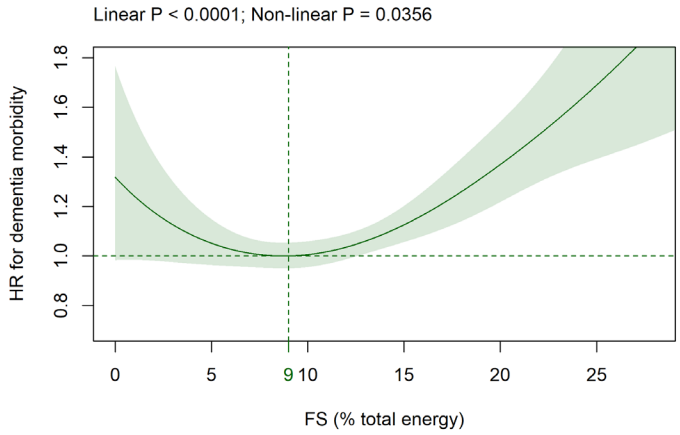


Figure S5 continued

(a)



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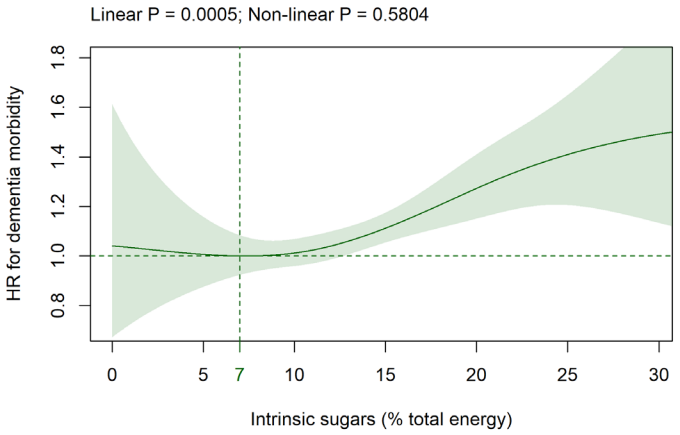

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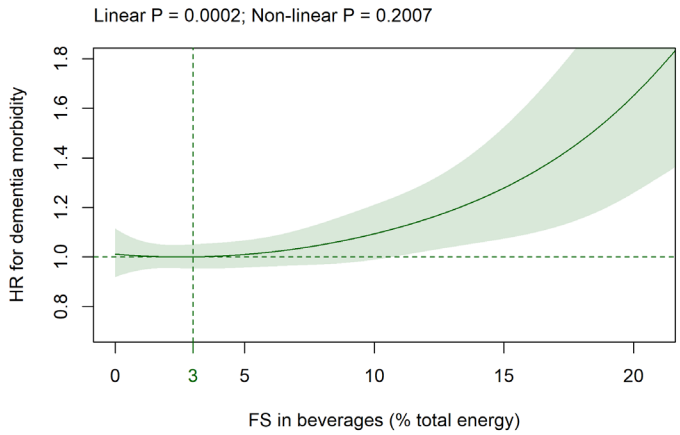

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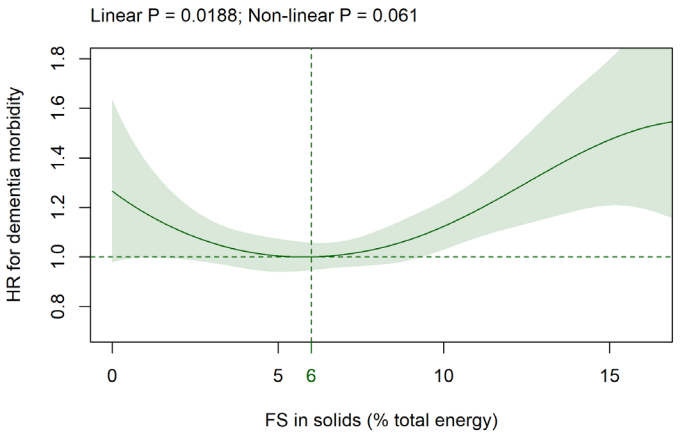

Figure S6

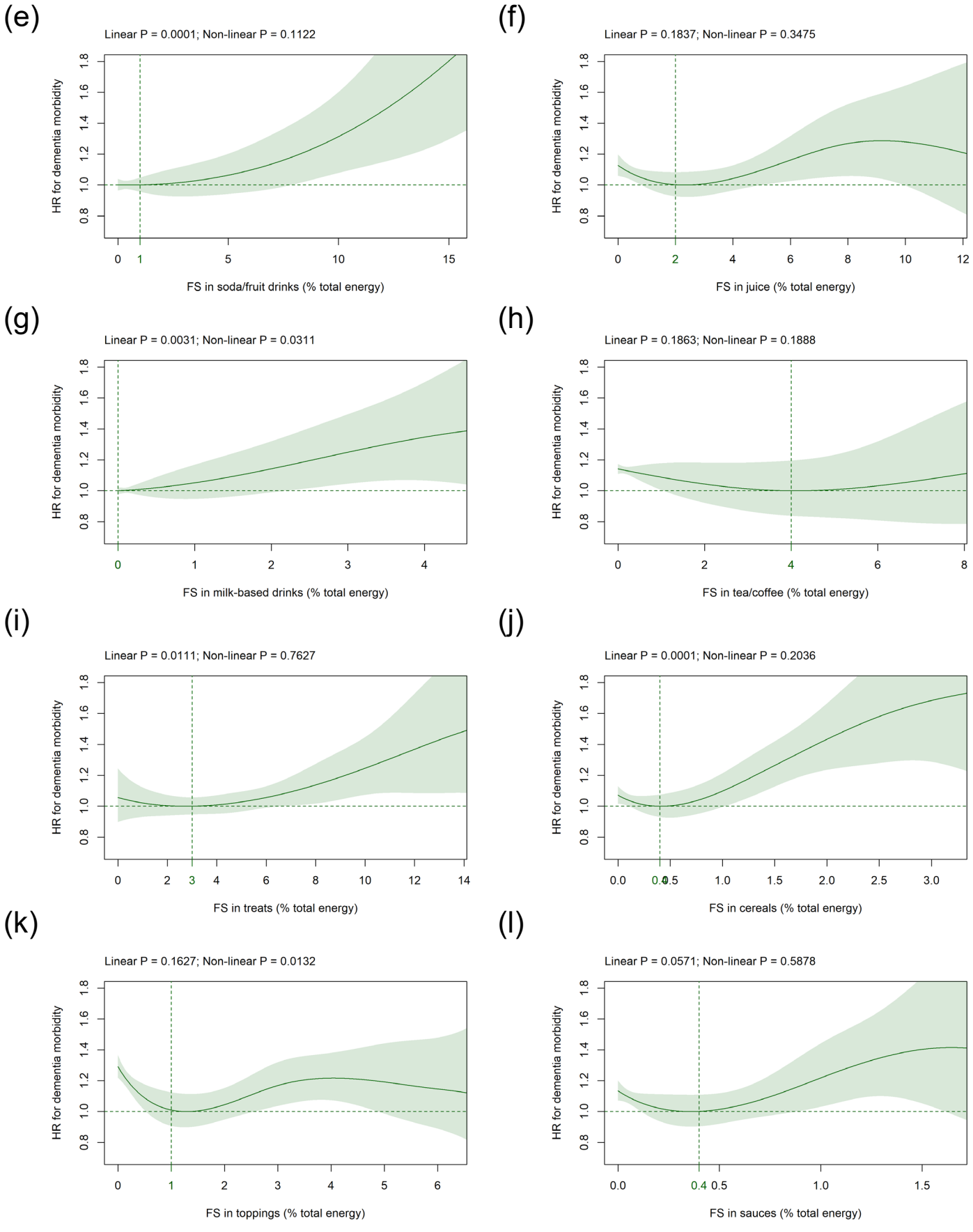

Figure S6 continued

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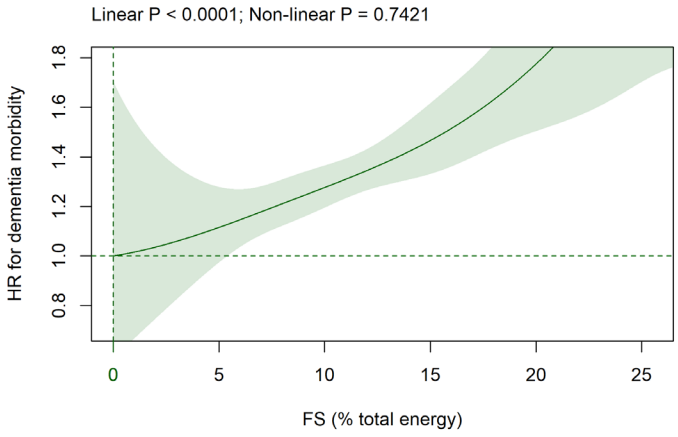

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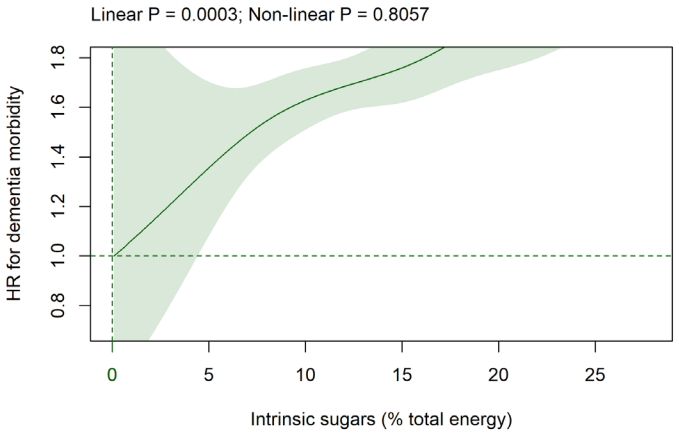

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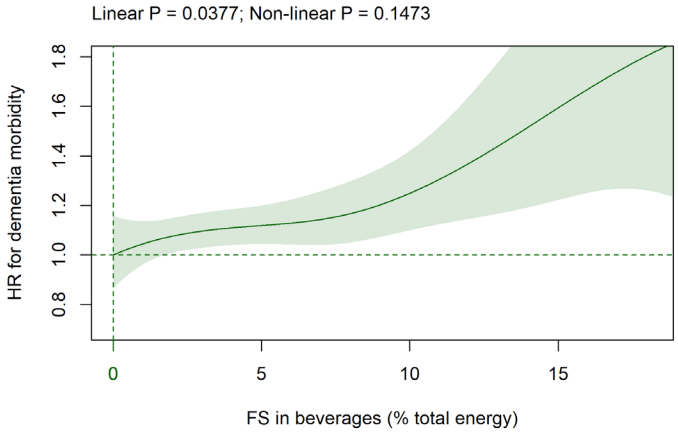

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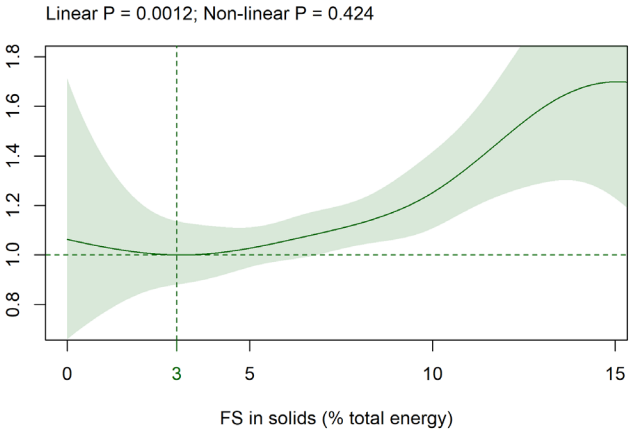


Figure S7

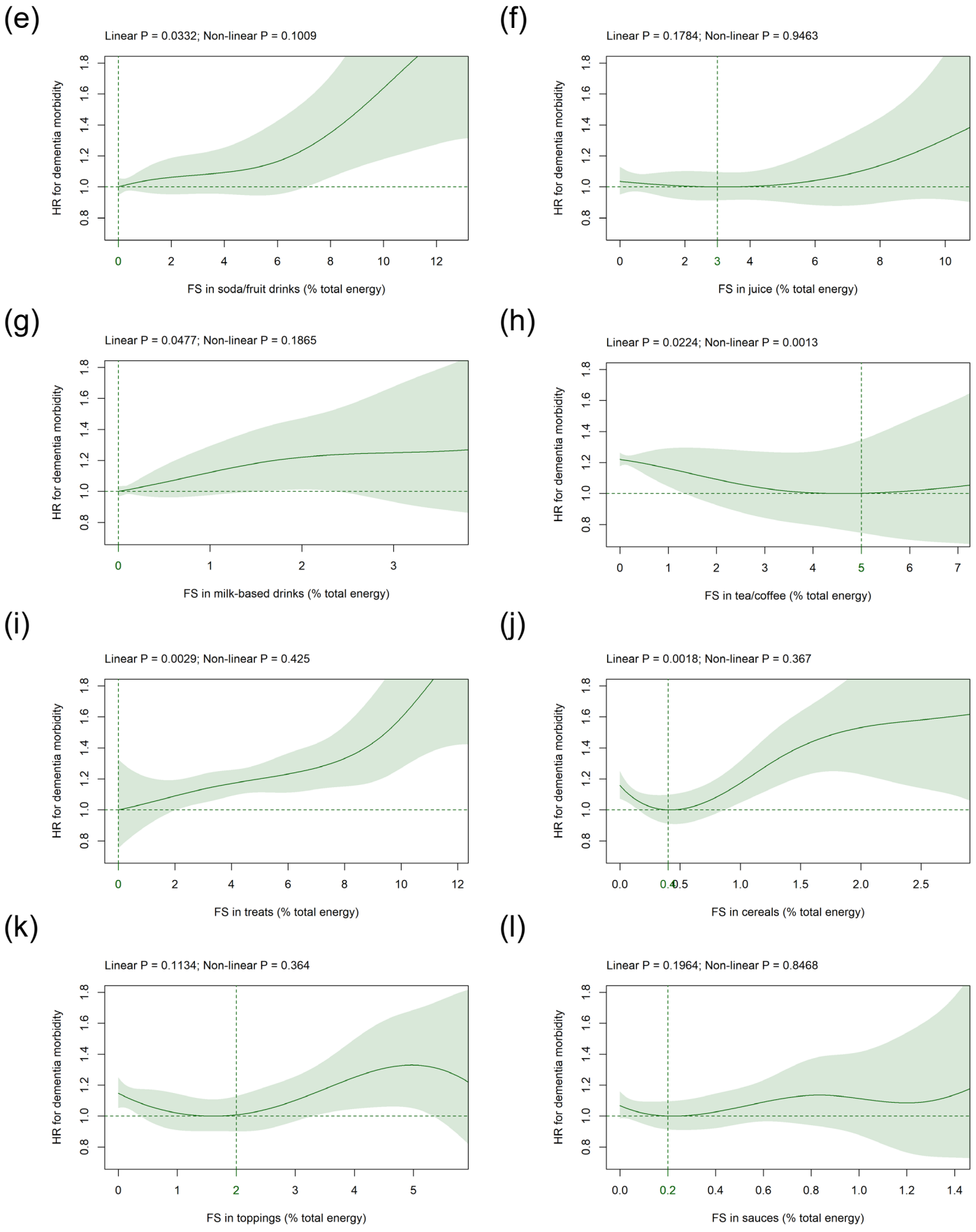
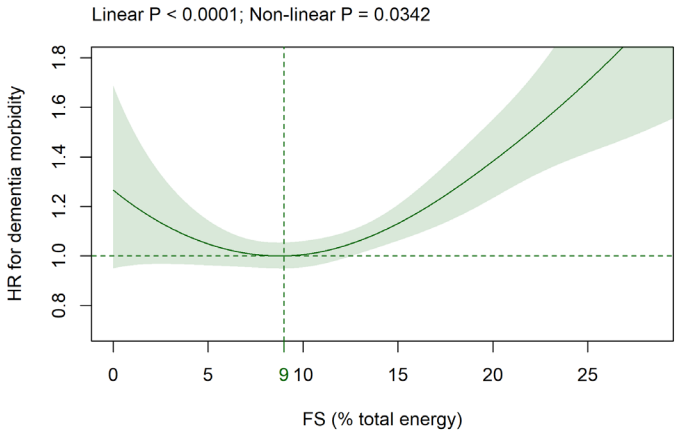


Figure S7 continued

(a)



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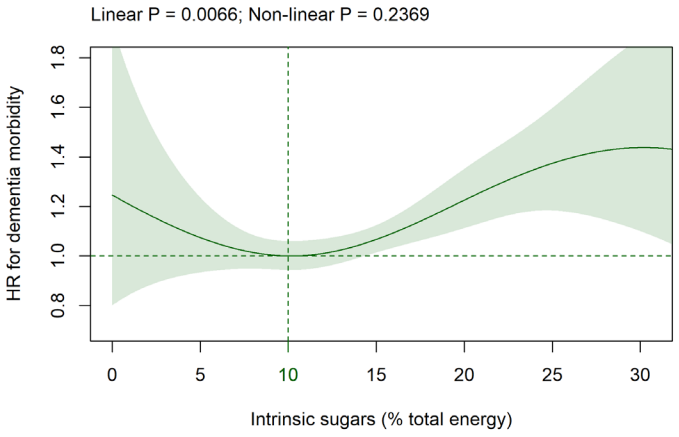

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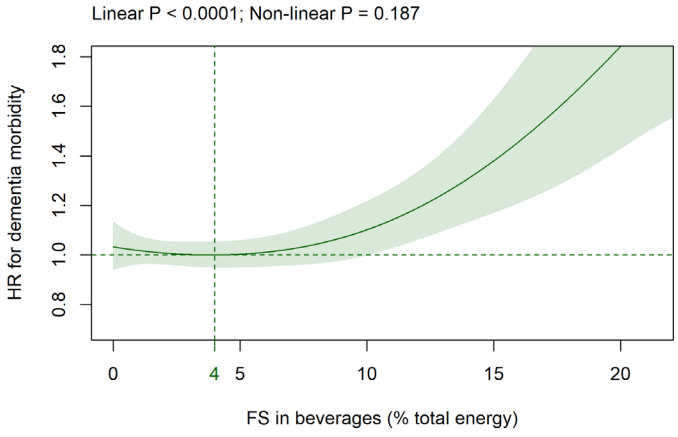

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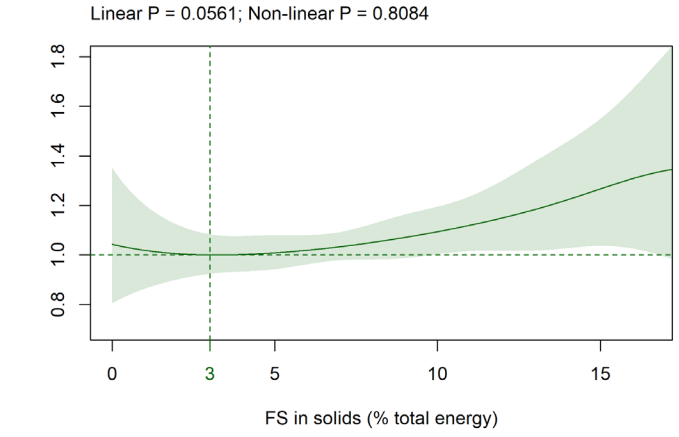


Figure S8

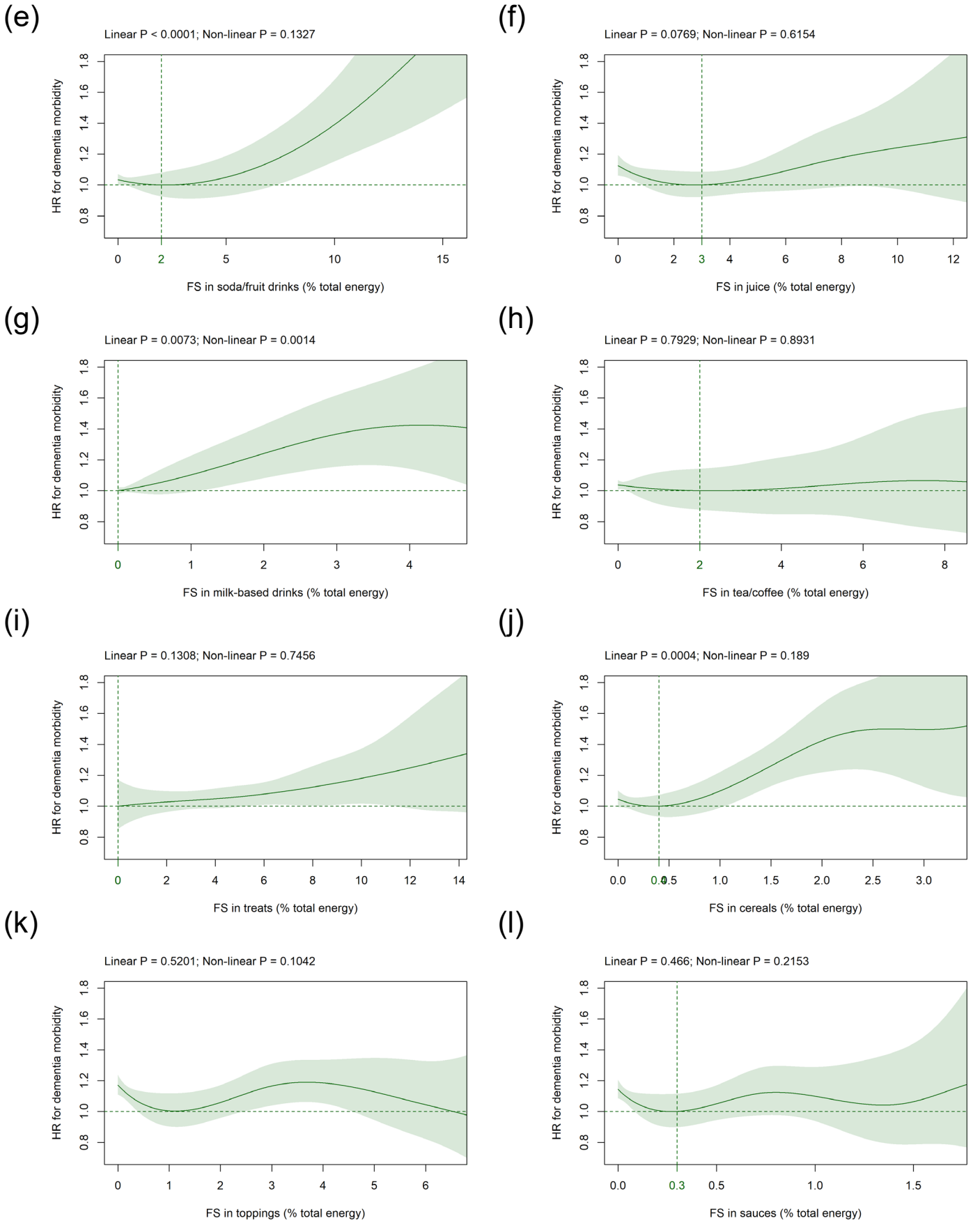
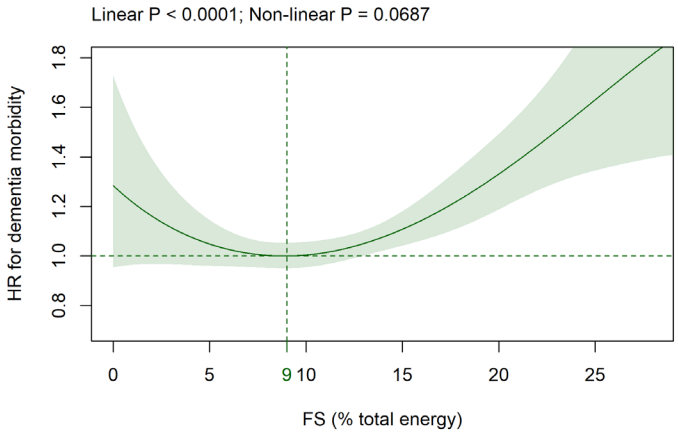


Figure S8 continued

(a)



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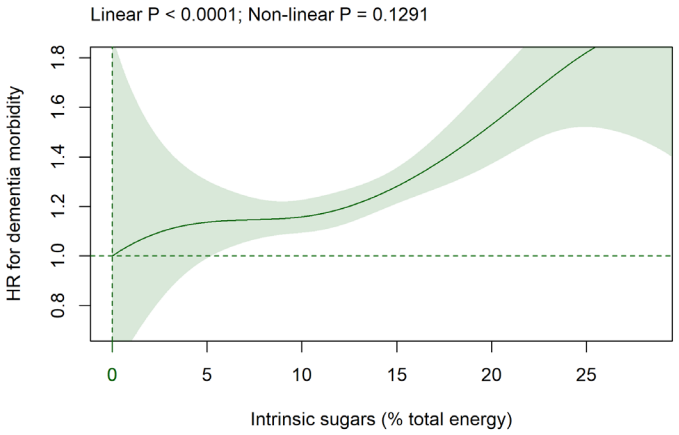

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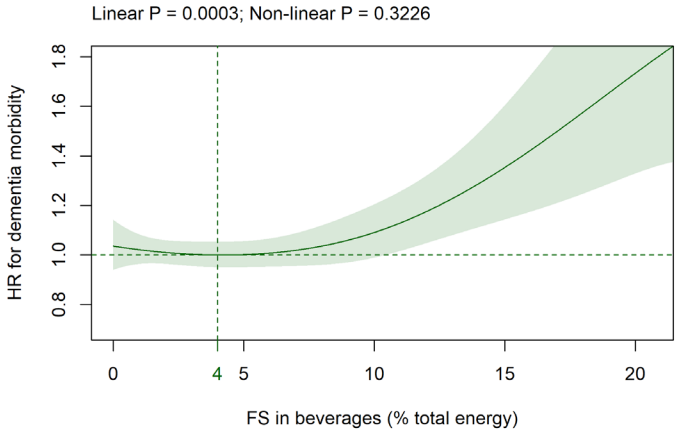

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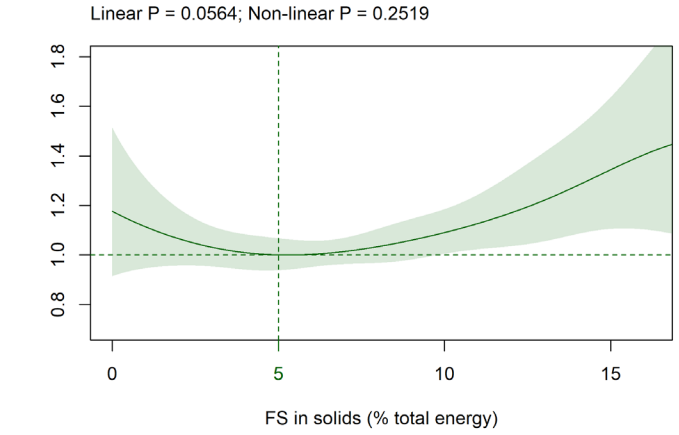


Figure S9

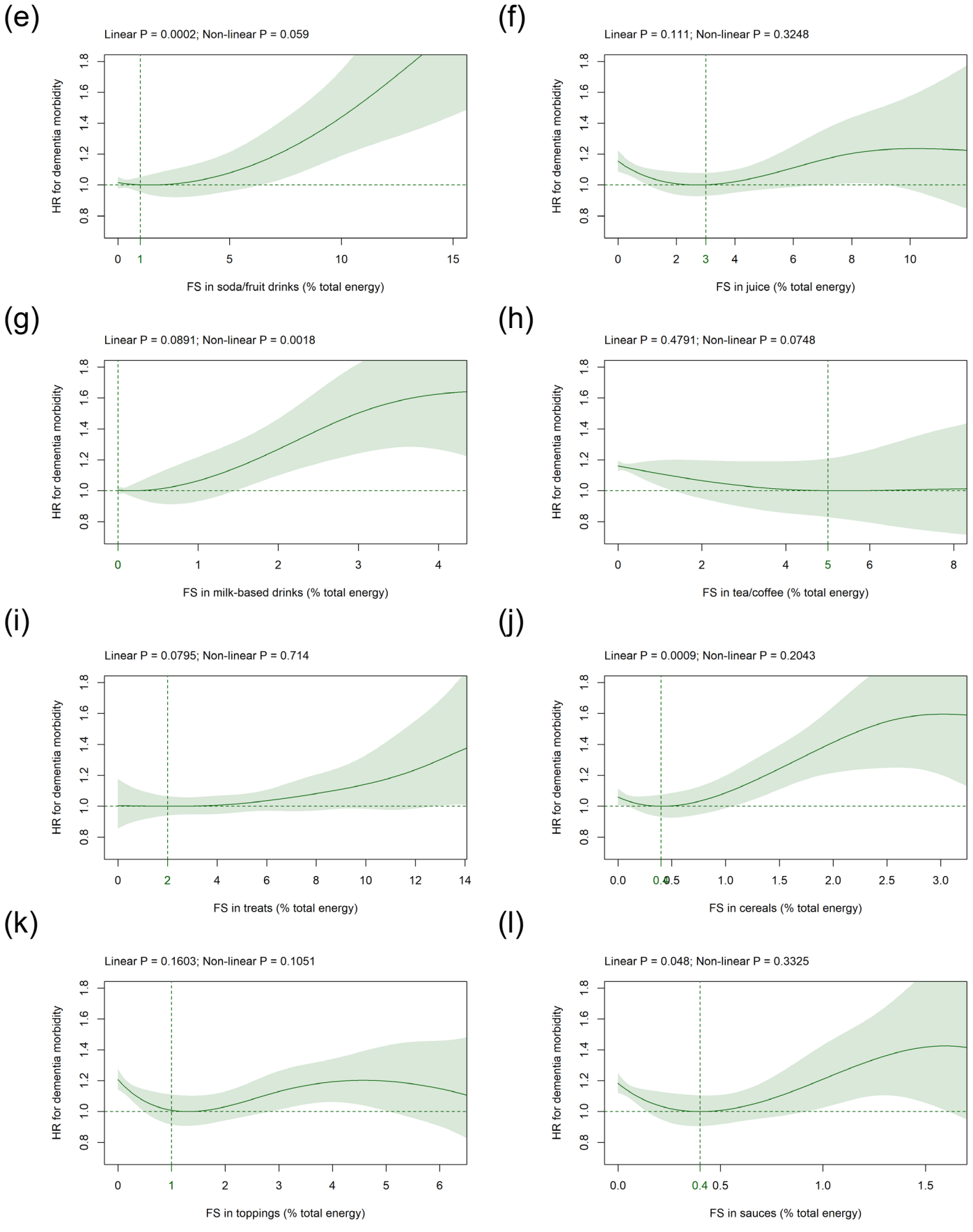
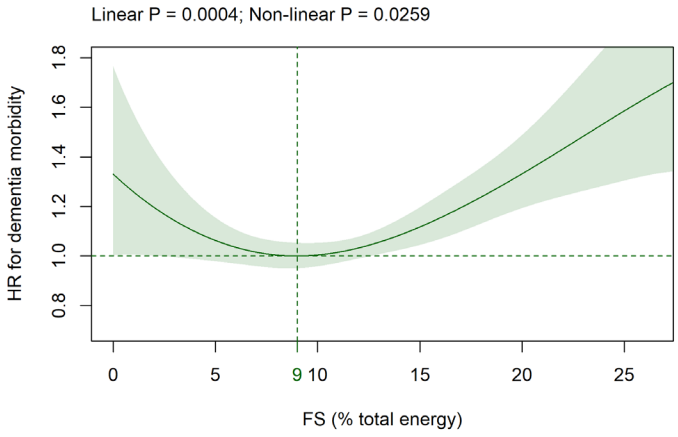


Figure S9 continued

(a)



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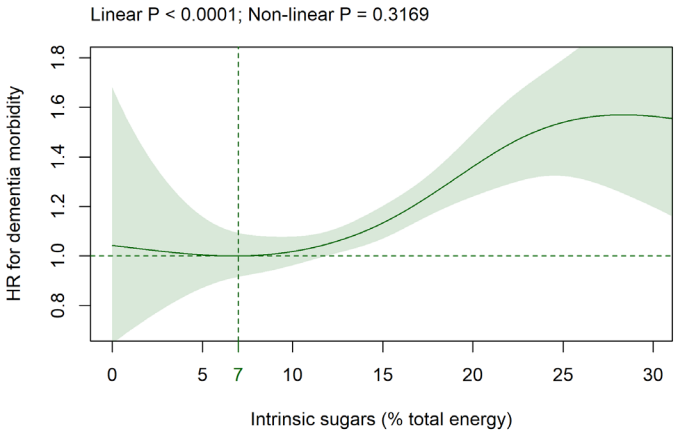

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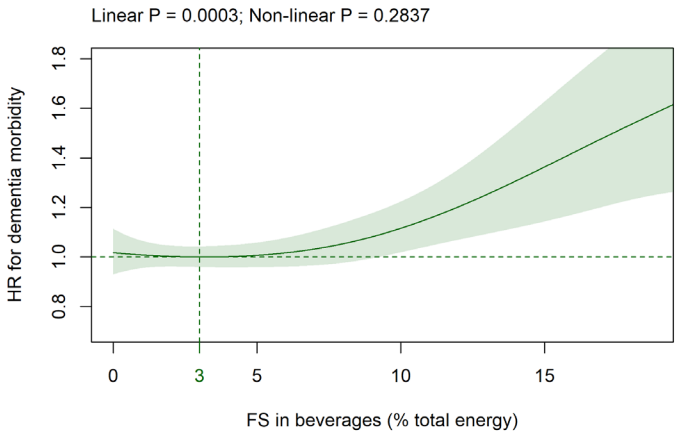

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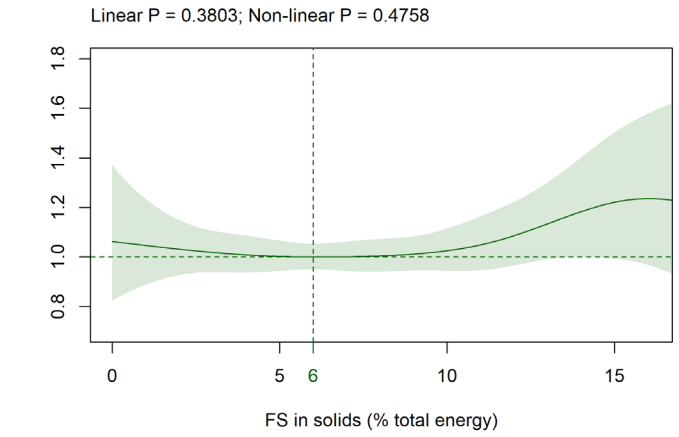


Figure S10

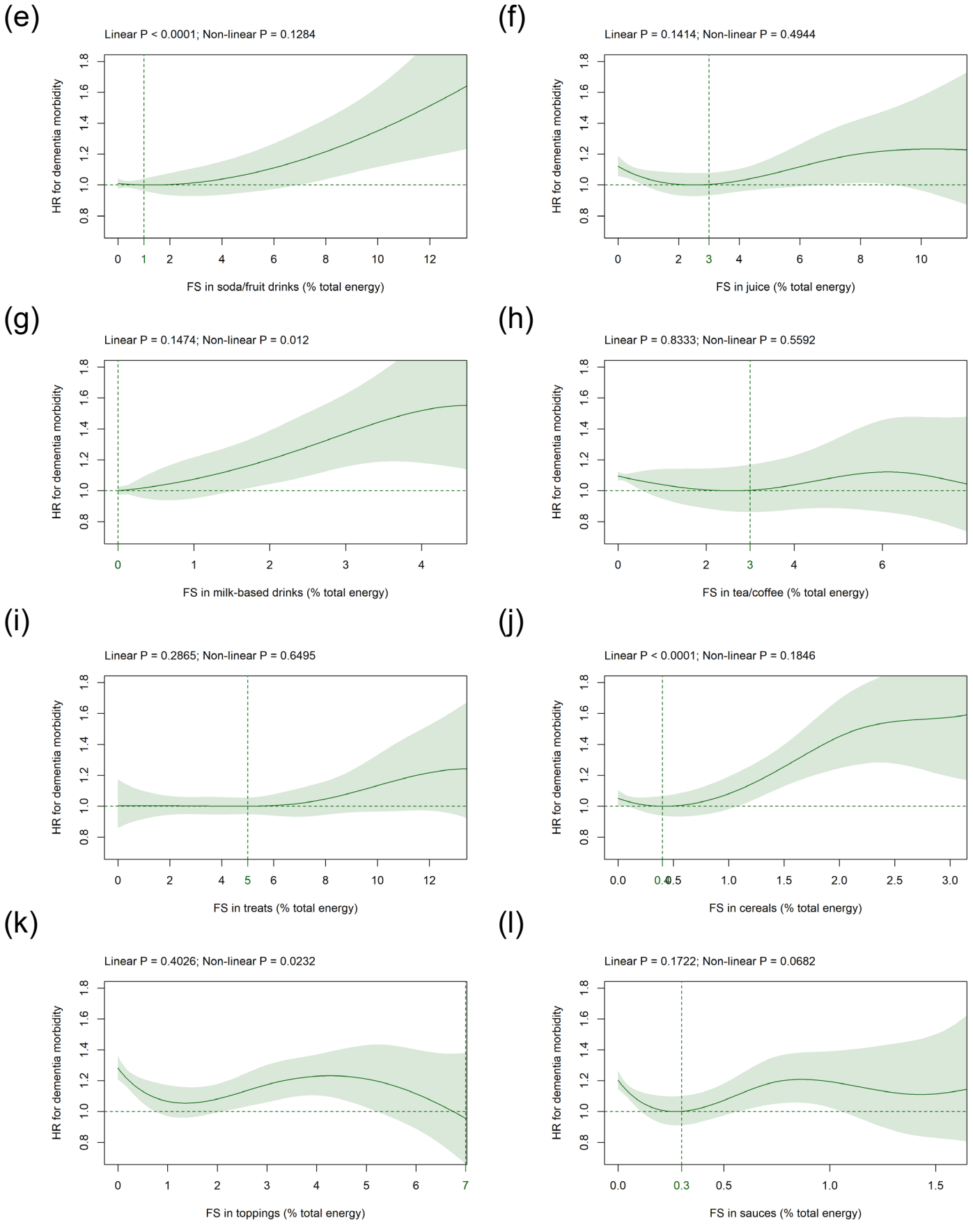
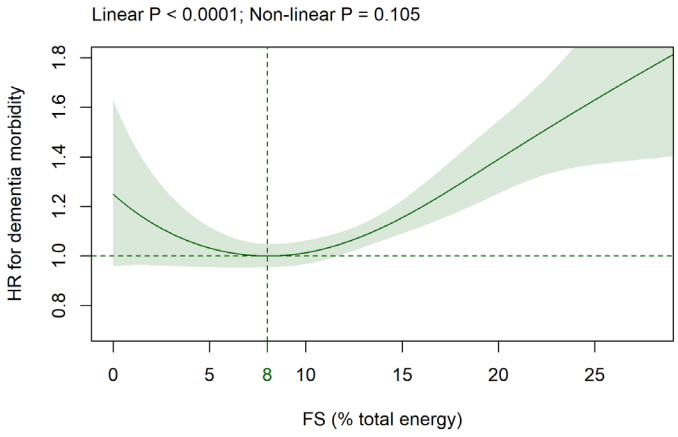
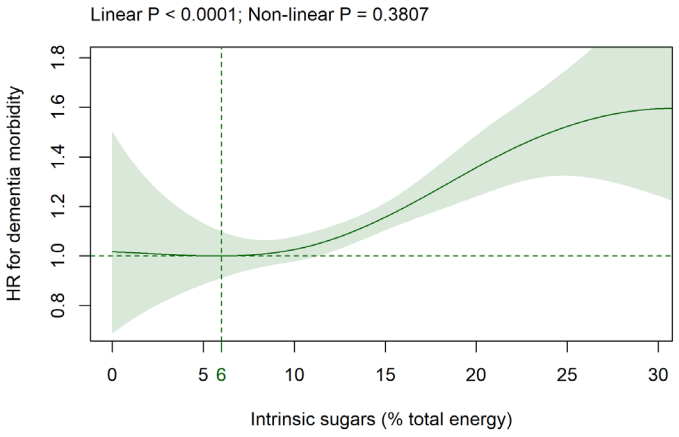


Figure S10 continued

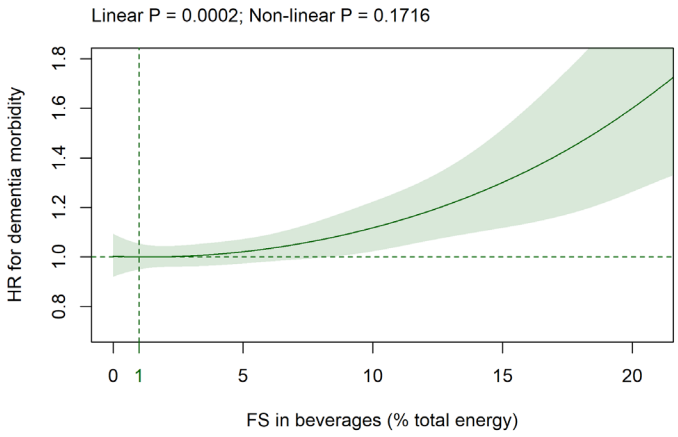
(a)



(b)



(c)



(d)

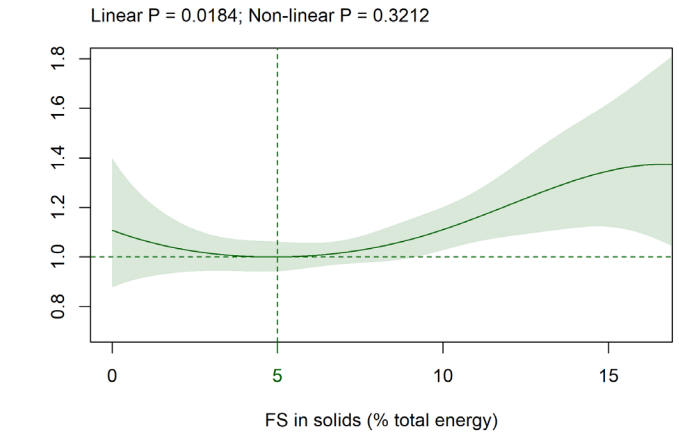


Figure S11

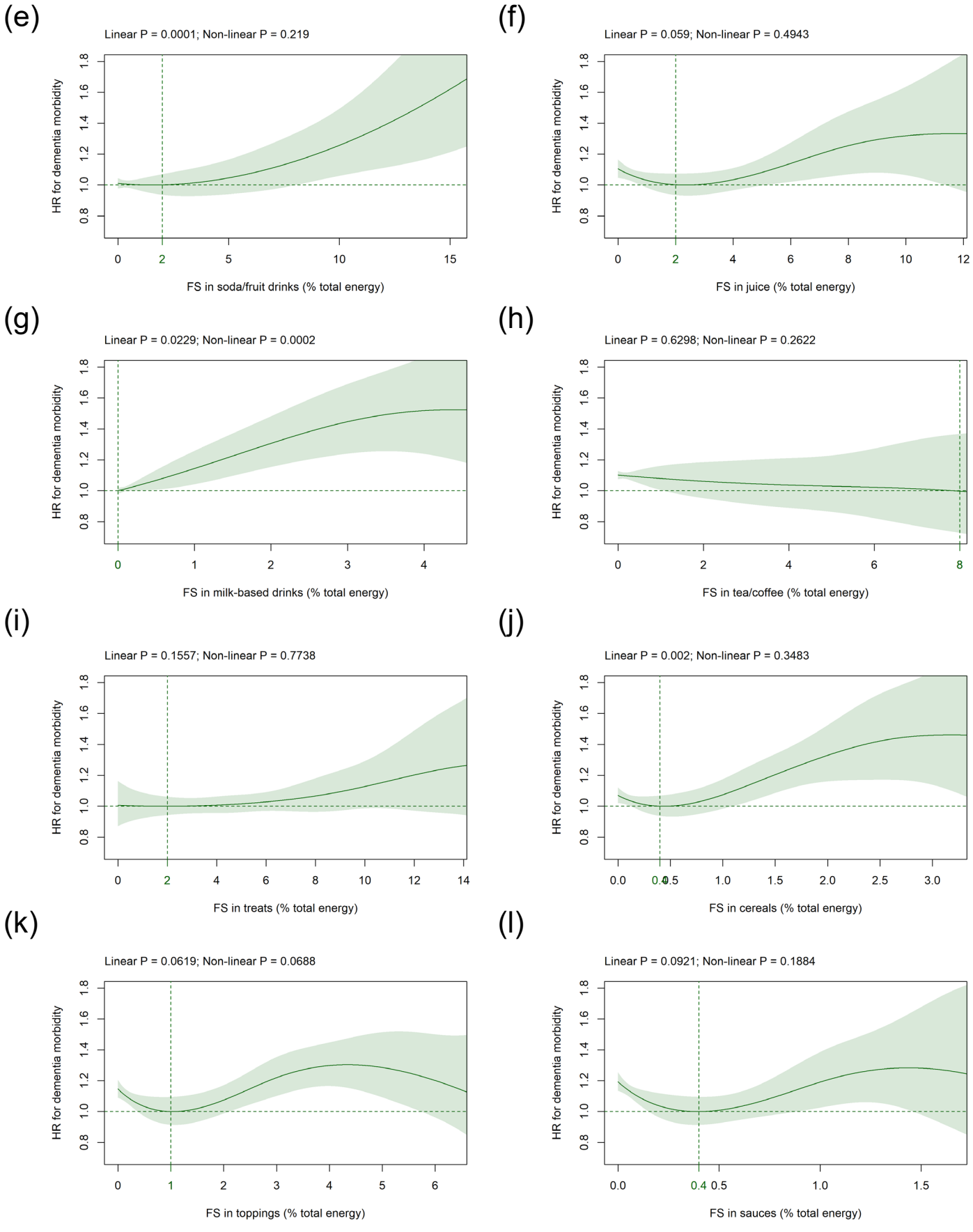
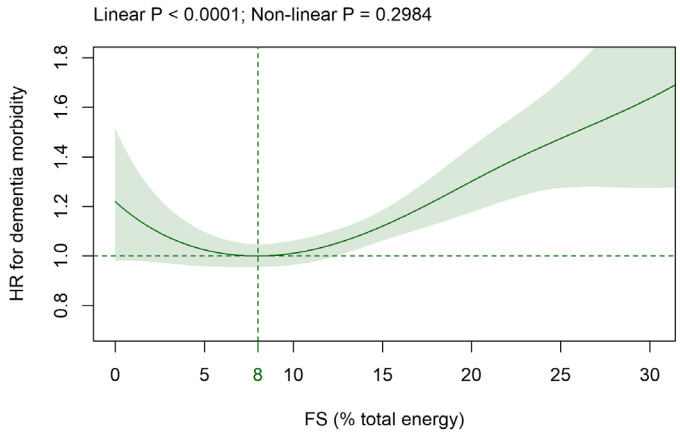


Figure S11 continued

(a)



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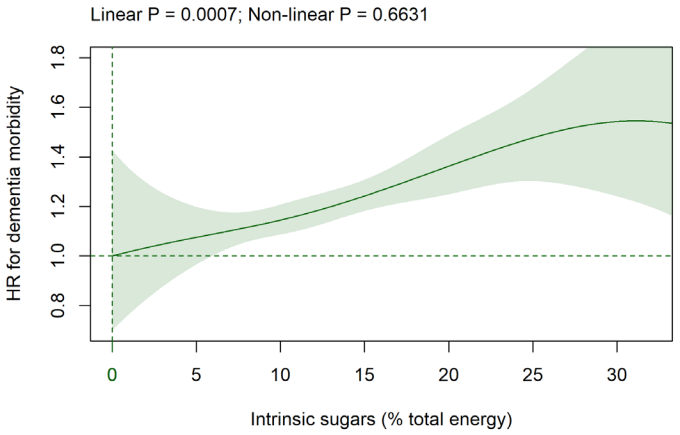

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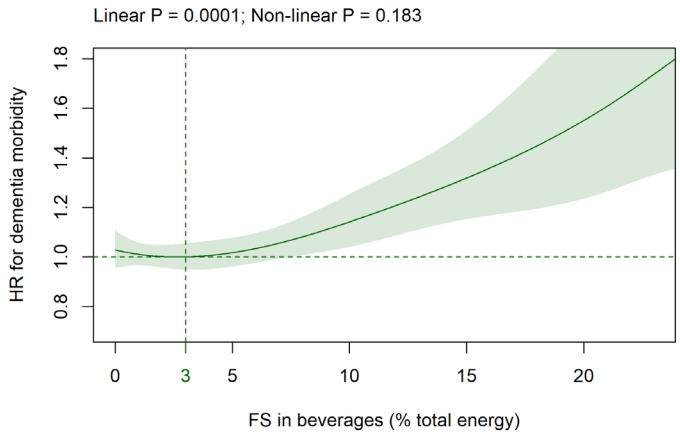

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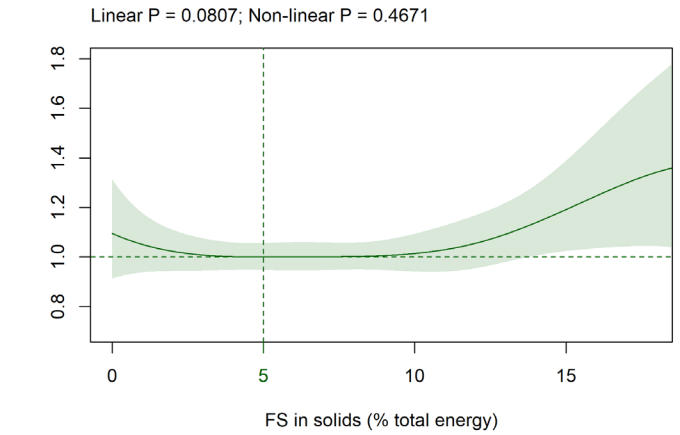


Figure S12

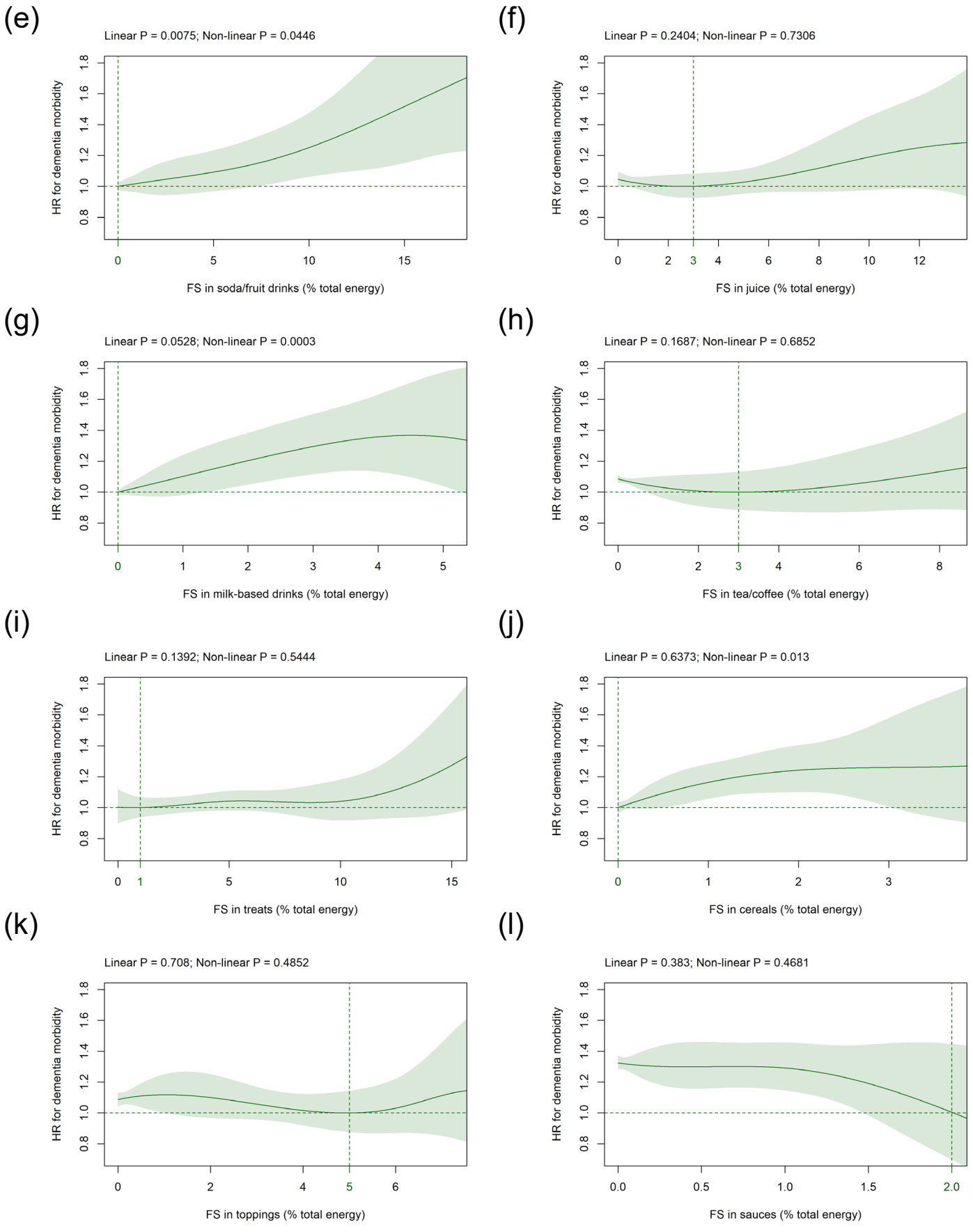
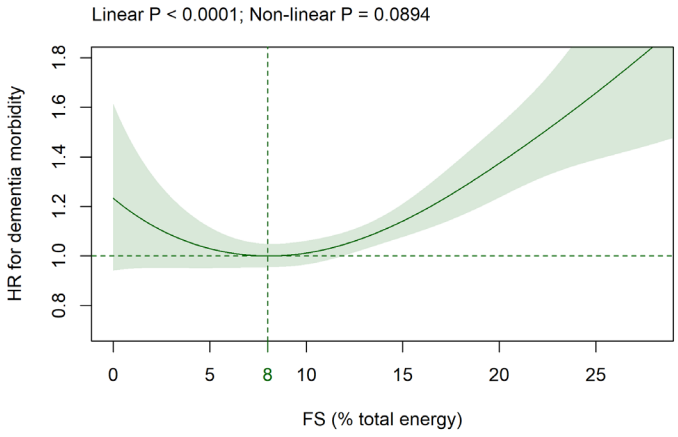


Figure S12 continued

(a)



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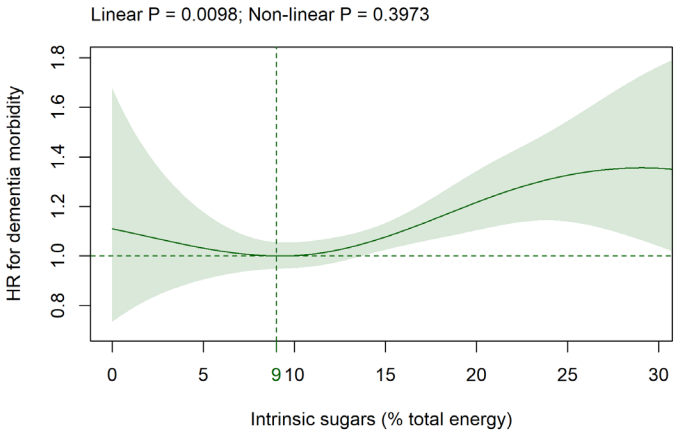

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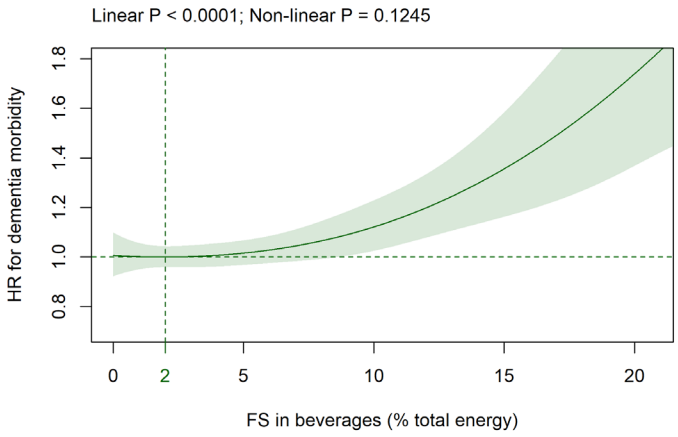

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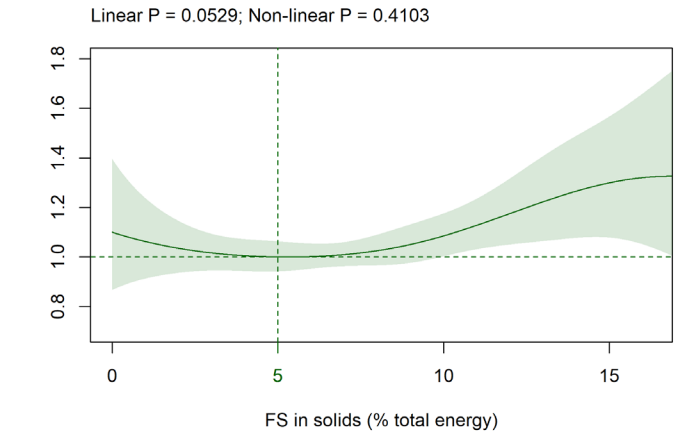


Figure S13

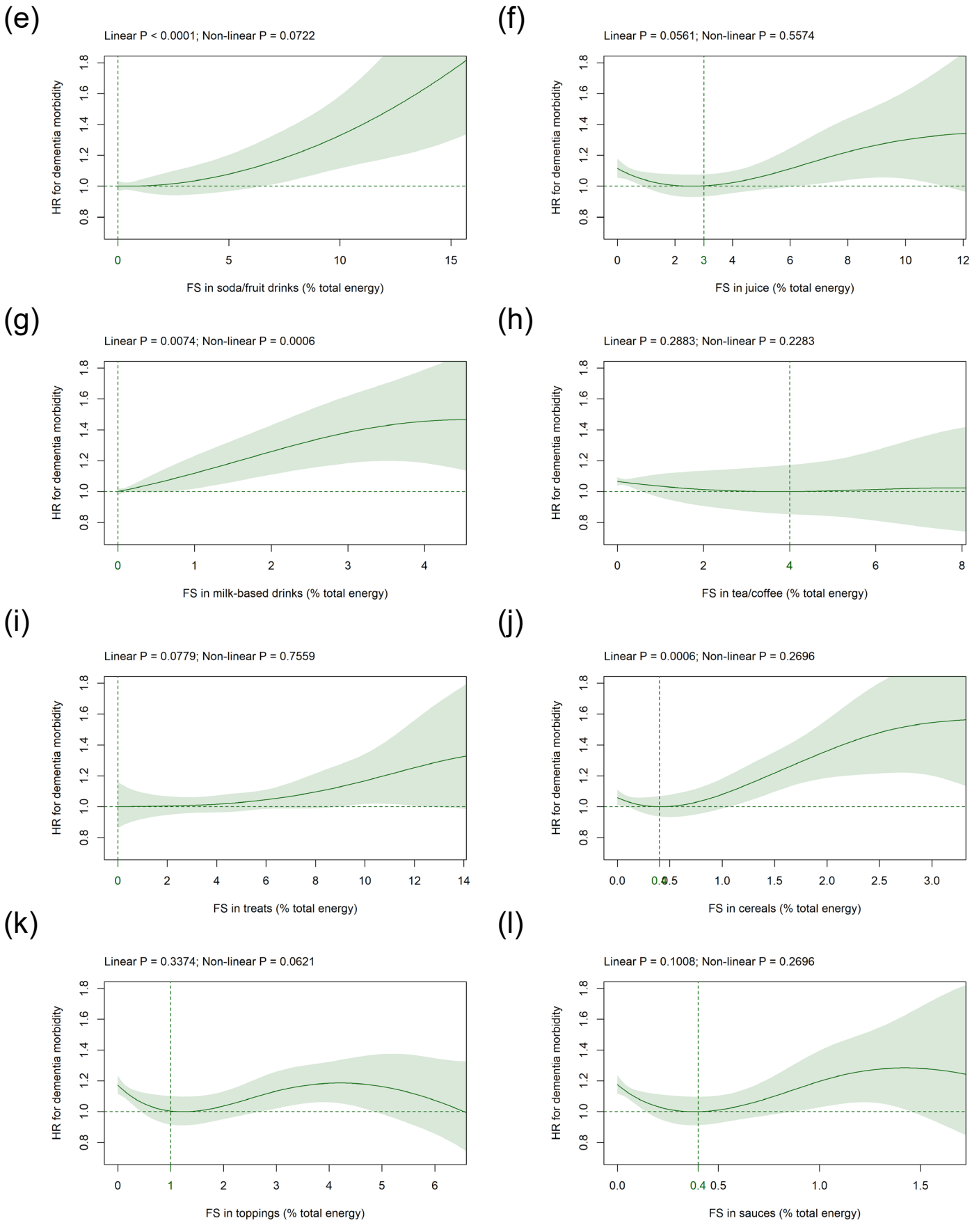
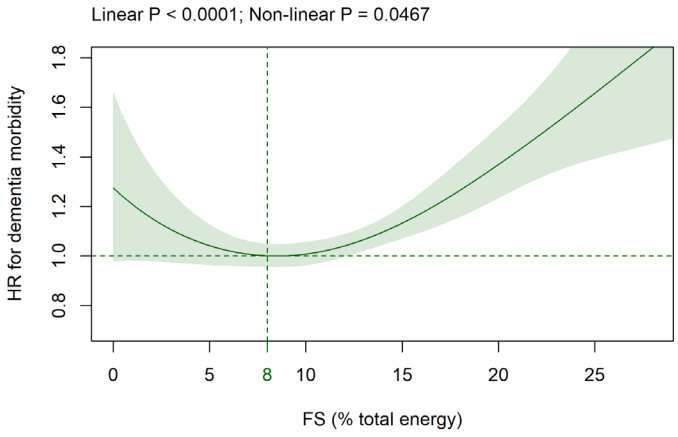


Figure S13 continued

(a)



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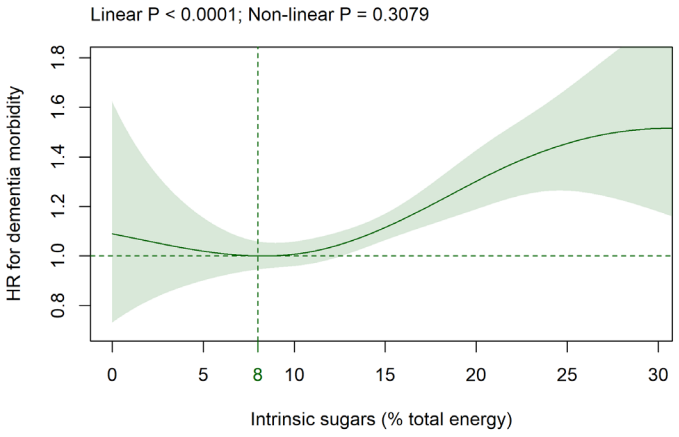

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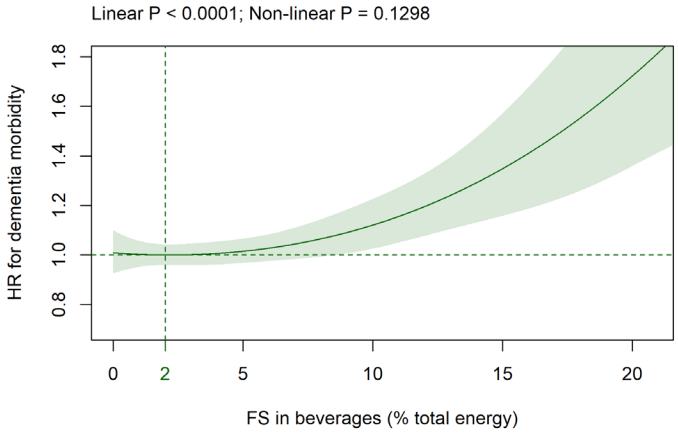

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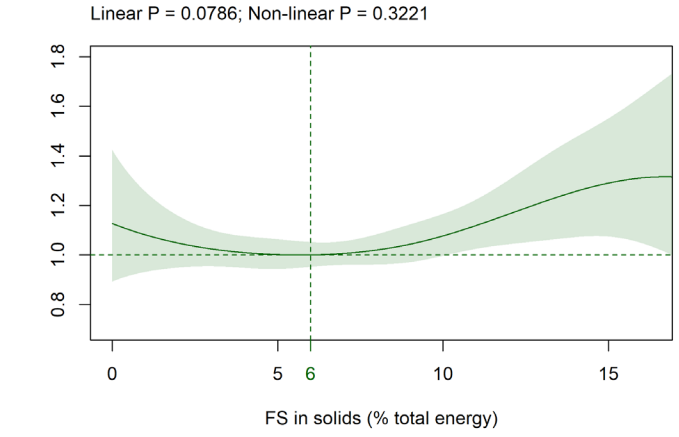


Figure S14

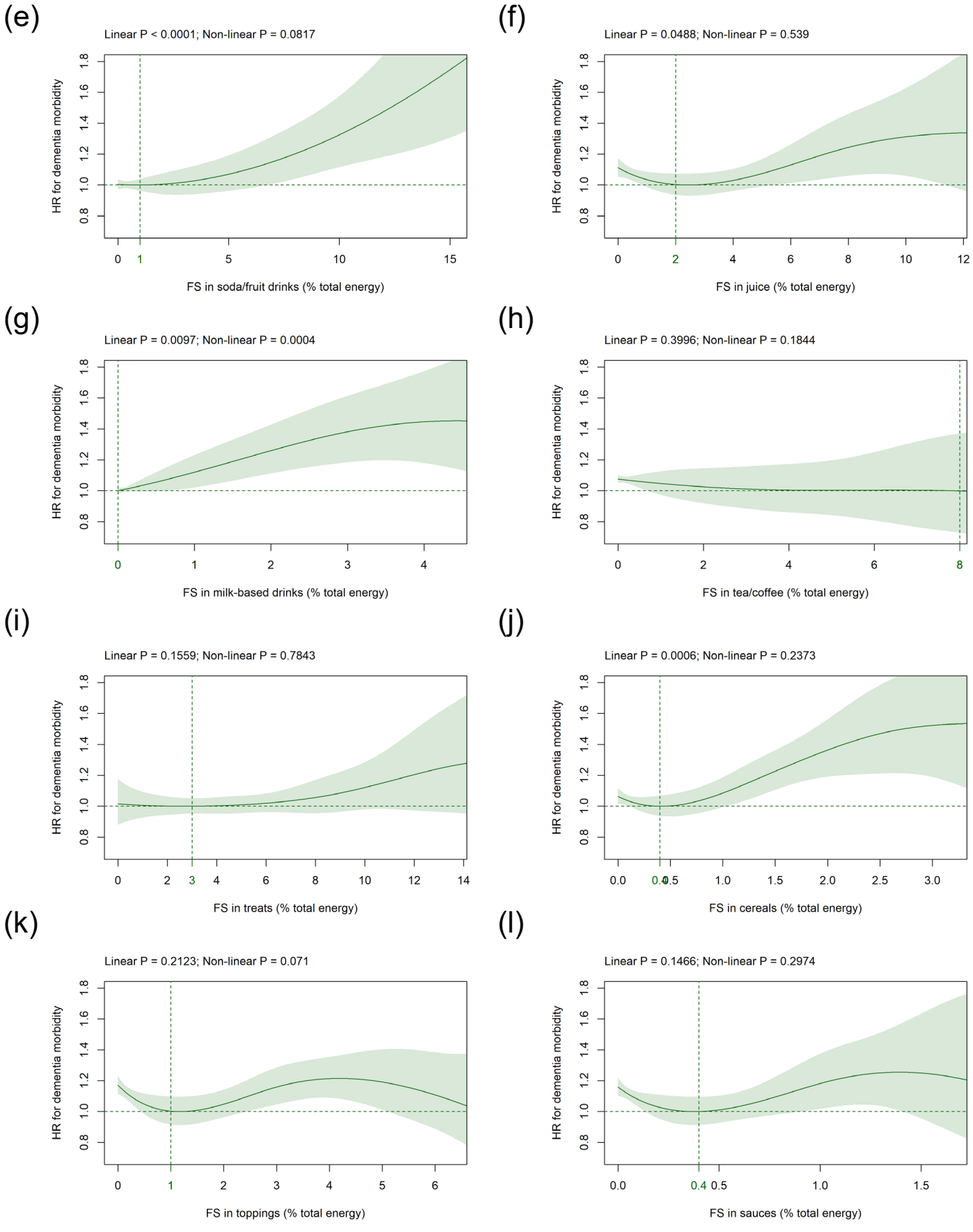
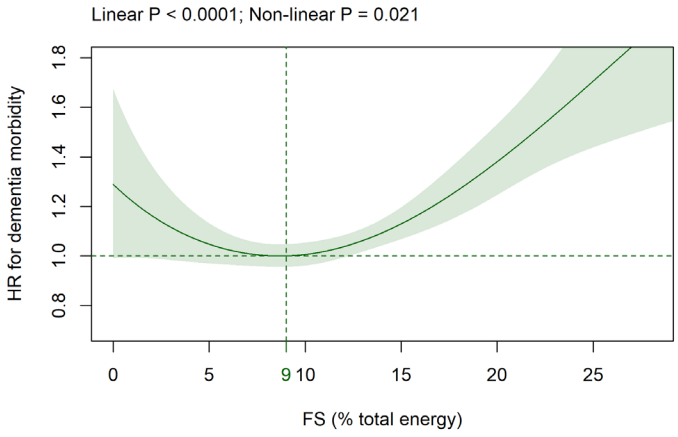
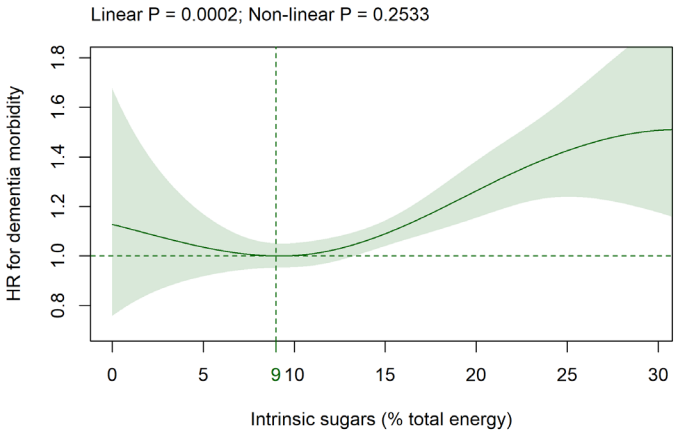


Figure S14 continued

(a)



(b)



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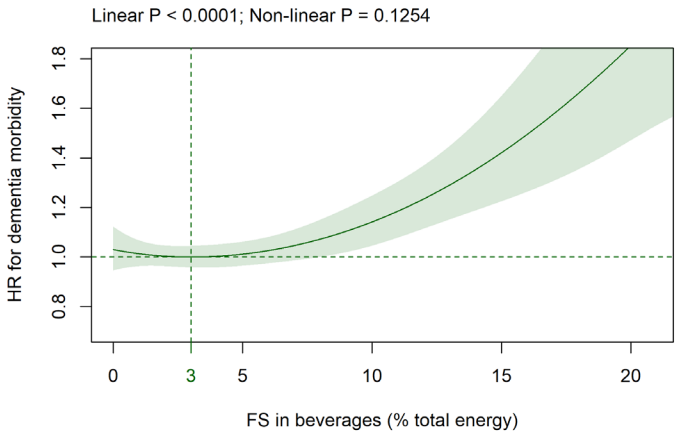

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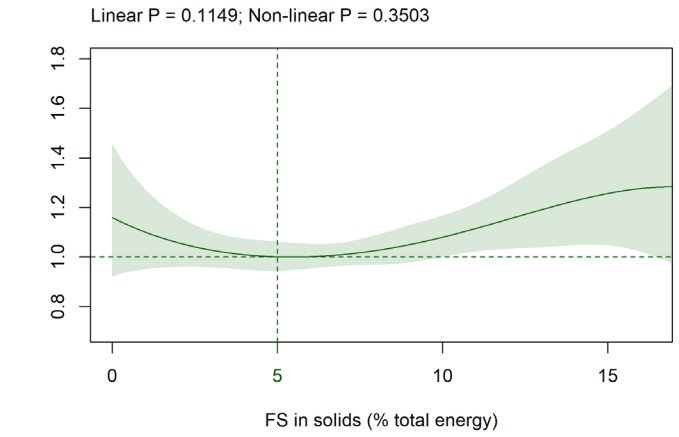


Figure S15

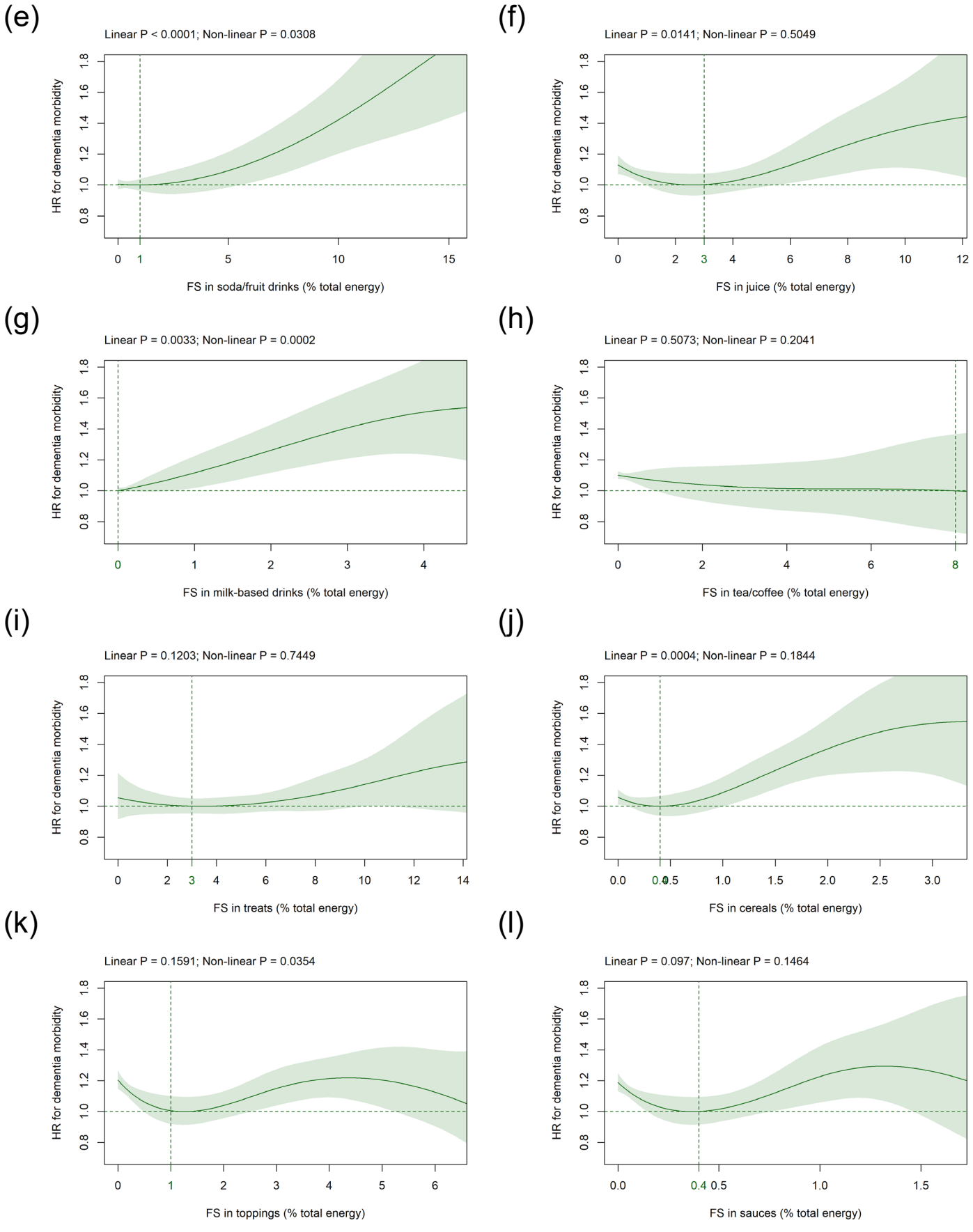
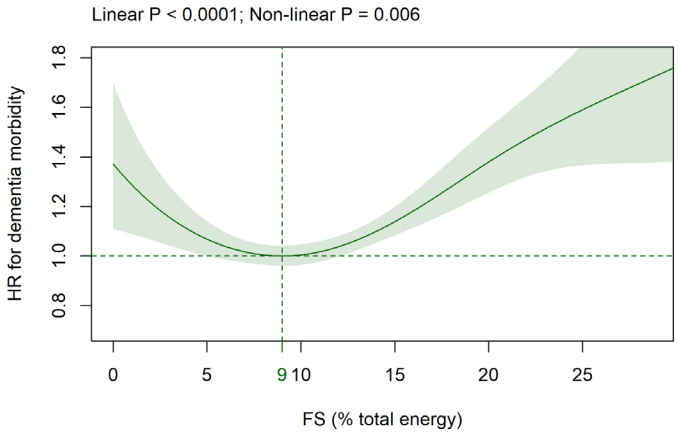
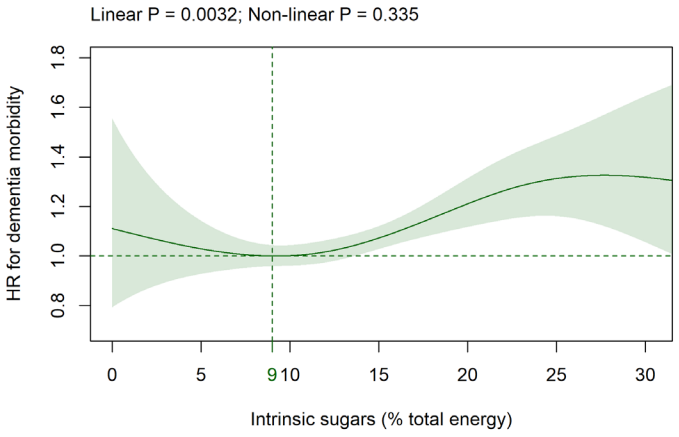


Figure S15 continued

(a)



(b)



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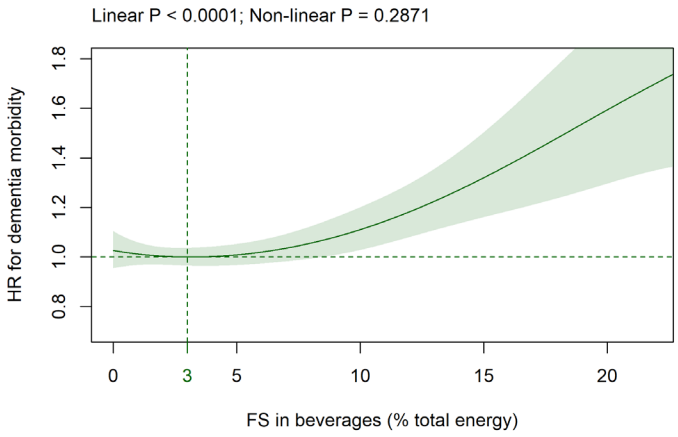

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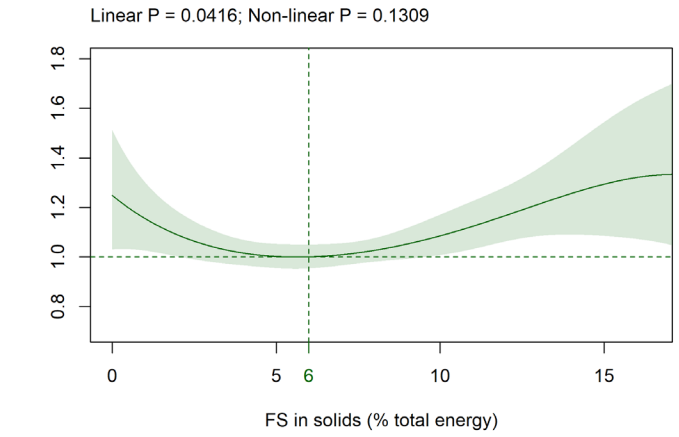

Figure S16

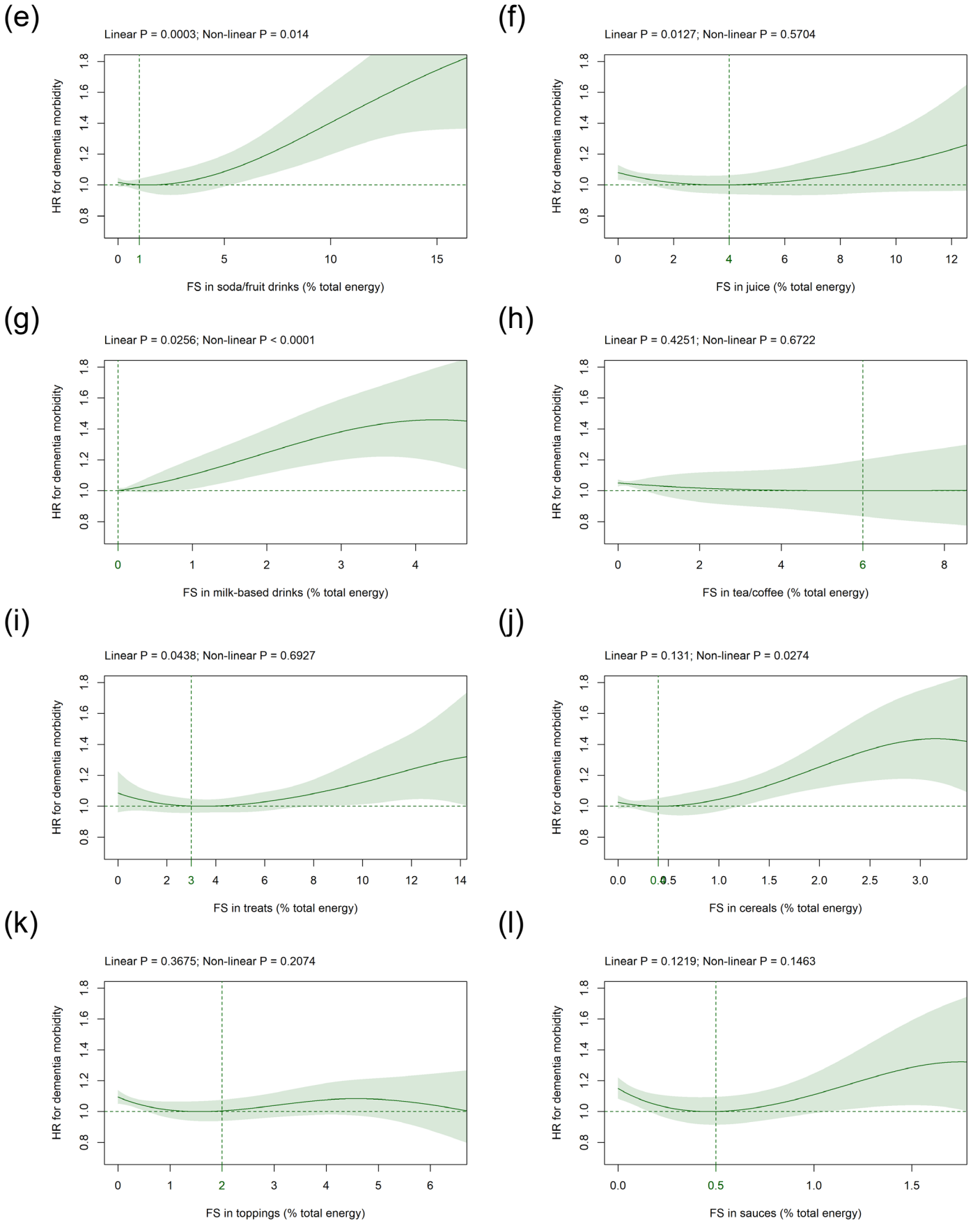

Figure S16 continued