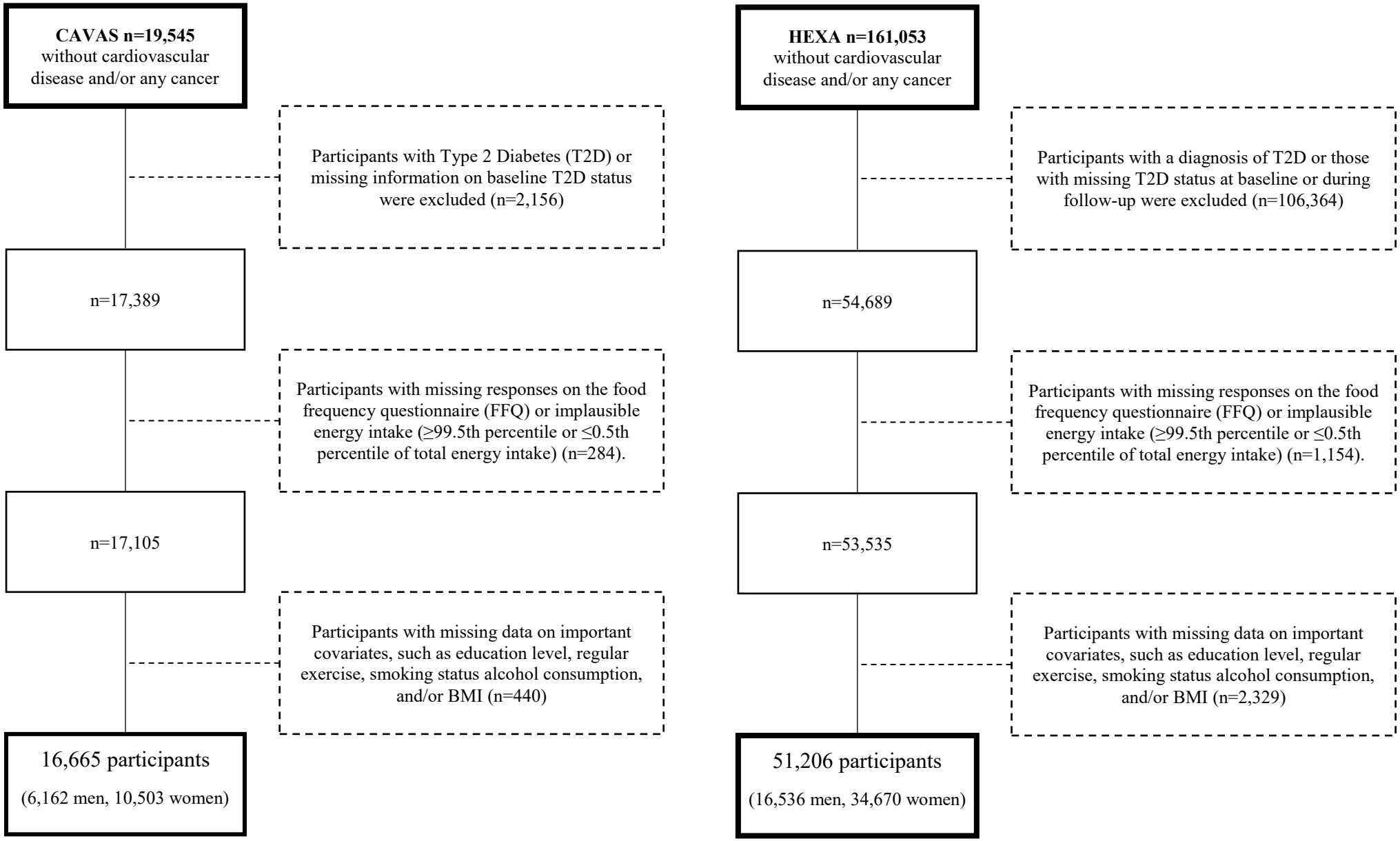
**Supplementary Figure S1. Flowchart of study in KoGES_CAVAS cohort and KoGES_HEXA cohort**



**Supplementary Table 1.** Description of 45foods

| No. | Foods *(Serving/day)* | *Abbreviation* | No. of items* | Food items |
|---|---|---|---|---|
| 1 | Total rice* | *tRice* | 5 | Cooked white rice, Cooked rice with beans, Cooked rice with multi-grains |
| 2 | Noodles | *Noodles* | 4 | Ramyon, Kalguksu/Jangguk-noodles/Udon, Chajangmyon/ Champpong, Naengmyeon/Buckwheat noodles |
| 3 | Dumpling and Tteokguk | *DumplTeok* | 2 | Dumpling/Dumpling soup, plain stick shaped-rice cake/ Tteokguk (plain stick shaped-rice cake soup) |
| 4 | Rice cakes | *RiceCake* | 1 | Other rice cakes (Steamed rice cake, Baekseolgi, Injeolmi, etc.) |
| 5 | Cornflakes | *Cornflake* | 1 | Cornflakes |
| 6 | Breads/spreads | *Bread* | 2 | Loaf bread/sandwich/toast, jam/honey/margarine |
| 7 | Bread products | *SwBread* | 3 | Bread with small red bean, other breads (streusel bread/nut cake/castella/cream bread), cake /chocopie |
| 8 | Cheese & pizza/hamburger | *Cheese/Fast* | 2 | Pizza/hamburger, cheese |
| 9 | Grain powder | *GrainPowder* | 1 | Powdered meals/parched cereal powder |
| 10 | Snack/confections | *Snacks* | 1 | Cookie/cracker/snack, candy/chocolate |
| 11 | Nuts and roasted beans | *Nuts* | 2 | Peanut/almond/pine nut, soybeans/soybeans cooked in soy sauce (include green beans, exclude rice with beans) |
| 12 | Soybean paste soup | *SoySoup* | 1 | Soybean paste soup/fast-fermented bean paste/soybean paste/ Ssamjang |
| 13 | Tofu/bean sprouts | *TofuBeanspr* | 2 | Tofu (soft tofu, tofu stew, and tofu in tofu stew), bean sprouts/mung bean sprouts |
| 14 | Eggs | *Egg* | 1 | Egg/quail egg |
| 15 | Starch | *Starch* | 2 | Muk (starch jelly), Japchae (starch vermicelli) |
| 16 | Potatoes | *Potato* | 2 | Potatoes (steamed, French fries, soup, stew, jeon, etc.), sweet potatoes (steamed sweet potatoes, Mattang, etc.) |
| 17 | Baechukimchi | *BaechuKimchi* | 1 | Baechukimchi/Baegkimchi/Baechukimchi in Kimchi stew |
| 18 | Other kimchi | *OthKimchi* | 3 | Kkakdugi/Radish Kimchi, Nabakkimchi/Dongchimi, Other Kimchi (Pakimchi/Kodulbbagi/Gatkimchi) |
| 19 | Salt-fermented food | *SaltFood* | 2 | Other pickled vegetables (garlic pickles, garlic stems, radish pickles), salt-fermented fish (salted squid, salted intestine, salted pollack roe, salted shrimp, salted anchovies, salted clams, etc.) |
| 20 | Cabbage/radish Soup | *VegSoup* | 2 | Radish (soup, stew)/pickled radish, cabbage/cabbage soup |
| 21 | Vegetable dish | *VegDish* | 7 | Spinach (spinach namul, soup, etc.), vegetable wraps/vegetable salad (cabbage, lettuce, kale, chicory, bok choy, broccoli, etc.), other green vegetables (shepherd's purse, beetroot, curled mallow, mugwort, outer leaves, etc.), Doraji/Deoduck (kind of white root), bracken/sweet potato stems/taro stem, red pepper leaves/Chamnamul/Chwinamul, crown daisies/leek/water dropwort, carrot/carrot juice |
| 22 | Lettuce/perilla leaf | *Leaves* | 2 | Lettuce (Ssam (rice and condiments wrapped in leaves of lettuce)/salad, etc.), perilla leaf |
| 23 | Mushrooms | *Mushroom* | 2 | Oyster mushroom (Pleurotus ostreatus), Other mushrooms (Wood ear mushroom (Auricularia heimuer), Button mushroom (agaricus bisporus), Winter mushroom (flammulina velutipes) etc.)) |
| 24 | Other vegetables | *OthVeg* | 4 | Cucumber, Onion, Green pepper, Pumpkin, immature |
| 25 | Sweet pumpkin | *SwPumpkin* | 1 | Pumpkin/Sweet pumpkin/Pumpkin juice |
| 26 | Poultry | *Poultry* | 1 | Fried chicken/Whole Chicken Soup/Samgyetang/Chicken Stew |
| 27 | By-products (organ meat, Seonji, Sundae) | *Bysprod* | 1 | By-products (Organ meat, Seonji, Sundae) |
| 28 | Cuttlefish | *Cuttlefish* | 1 | Cuttlefish/Dried cuttlefish/Small octopus |
| 29 | Pork | *Pork* | 3 | Pork belly, Pork-Pan roasted/Fried/Pork bulgogi/Meatball, Pork-steamed (Boiled pork, pork braised in soy sauce, pigs' feet) |
| 30 | Processed meat/Seafood | *ProcMeat/Sea* | 3 | Processed meat (Ham, sausage), Tuna, canned, Fish paste/Crab, flavored. |
| 31 | Beef | *Beef* | 3 | Steak/beef roast (Grilled ribs, Sirloin, Tenderloin, Beef bulgogi), Tang (Seolleongtang/Gomtang/Galbitang/ Doganitang), Soup (Beef soup, Yukgaejang, etc.) |
| 32 | Sliced raw fish and eel (special fish) | *RawFish* | 2 | Sliced Raw Fish, Eel |
| 33 | Dog meat | *DogMeat* | 1 | Dog meat |
| 34 | Fish | *Fish* | 4 | Blue-colored back fish (Mackerel/Pacific saury/Spanish mackerel), Hair tail, Yellow croaker/Snapper/Halibut, Alaska pollack/Frozen Alaska pollack/Dried Alaska pollock |
| 35 | Anchovy | *Anchovy* | 1 | Dried anchovy/Stir-fried dried anchovies |
| 36 | Seaweed | *Seaweed* | 2 | Laver-dried, Kelp/Sea mustard |

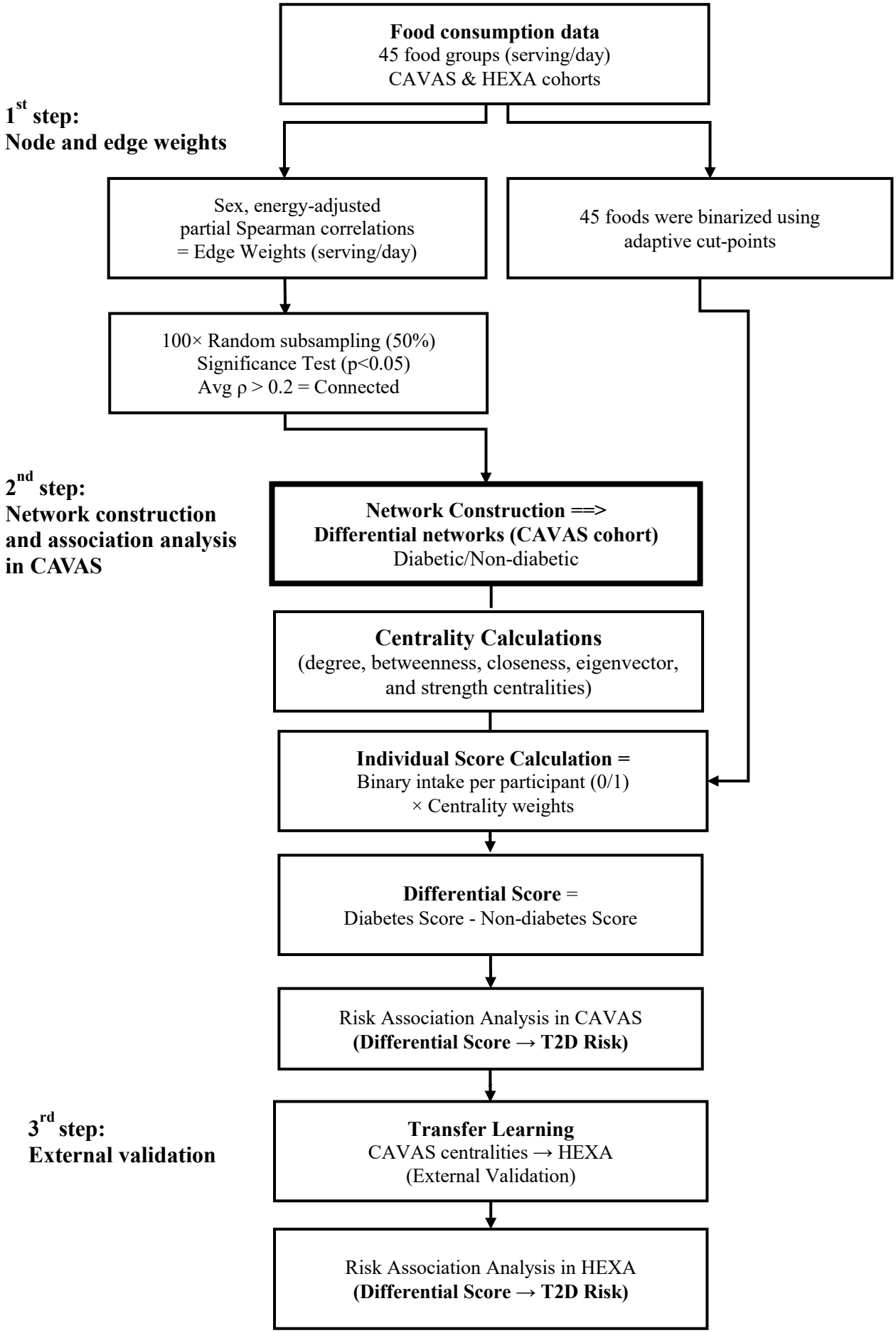
| | | | | |
|---|---|---|---|---|
| 37 | Shellfish seafood | *Shellfish* | 4 | Clam (Small ark shell/Little neck clam/Clam meat)/Whelk (including Soup, Stew, Roast, Kalguksu, Salad, etc.), Oysters (including Salted oysters), Crab/Crab preserved in soy sauce, Shrimp |
| 38 | Milk/yogurt | *Milk* | 2 | Milk, Yogurt/Yoplait |
| 39 | Carbonated drink/ice cream | *Soda/Ice,* | 2 | Ice cream, Carbonated drinks (Coke, Sprite) |
| 40 | Soy milk | *SoyMilk* | 1 | Soy milk |
| 41 | Coffee | *Coffee* | 3 | Coffee, Coffee Sugar, Coffee Cream |
| 42 | Traditional beverages | *TradDrink* | 1 | Other beverages (Citron tea, Plum tea, Aloe, Persimmon punch, Ginseng tea, Sikhye, Jujube tea, Black herbal tea, etc.) |
| 43 | Green tea | *GTea* | 1 | Green tea |
| 44 | Native fruit† | *DomFruit* | 10 | Korean melon/Melon, Watermelon, Peach/Plum, Persimmon, hard/Persimmon, dried, Tangerine, Korean pear/Pear juice, Apple/Apple juice, Grapes/Grapes juice, Tomato/Tomato juice/Cherry tomato |
| 45 | Non-native fruit‡ | *ImpFruit* | 2 | Banana, Orange/Orange juice |

*The same validated 106-item food frequency questionnaire was administered at baseline and follow-up visits in both CAVAS and HEXA cohorts. We consolidated these food items by merging five rice-related items (cooked white rice, cooked rice with beans, cooked rice with multi-grains, and two other rice varieties) into a single rice category. We then applied Ward's hierarchical clustering method with the Silhouette method to determine optimal clusters, considering predefined cluster numbers (20, 30, 40). After examining cluster interpretability and consistency, we ultimately identified 45 modified food groups.

† Native fruit referred to fruits primarily grown and consumed in Korea.

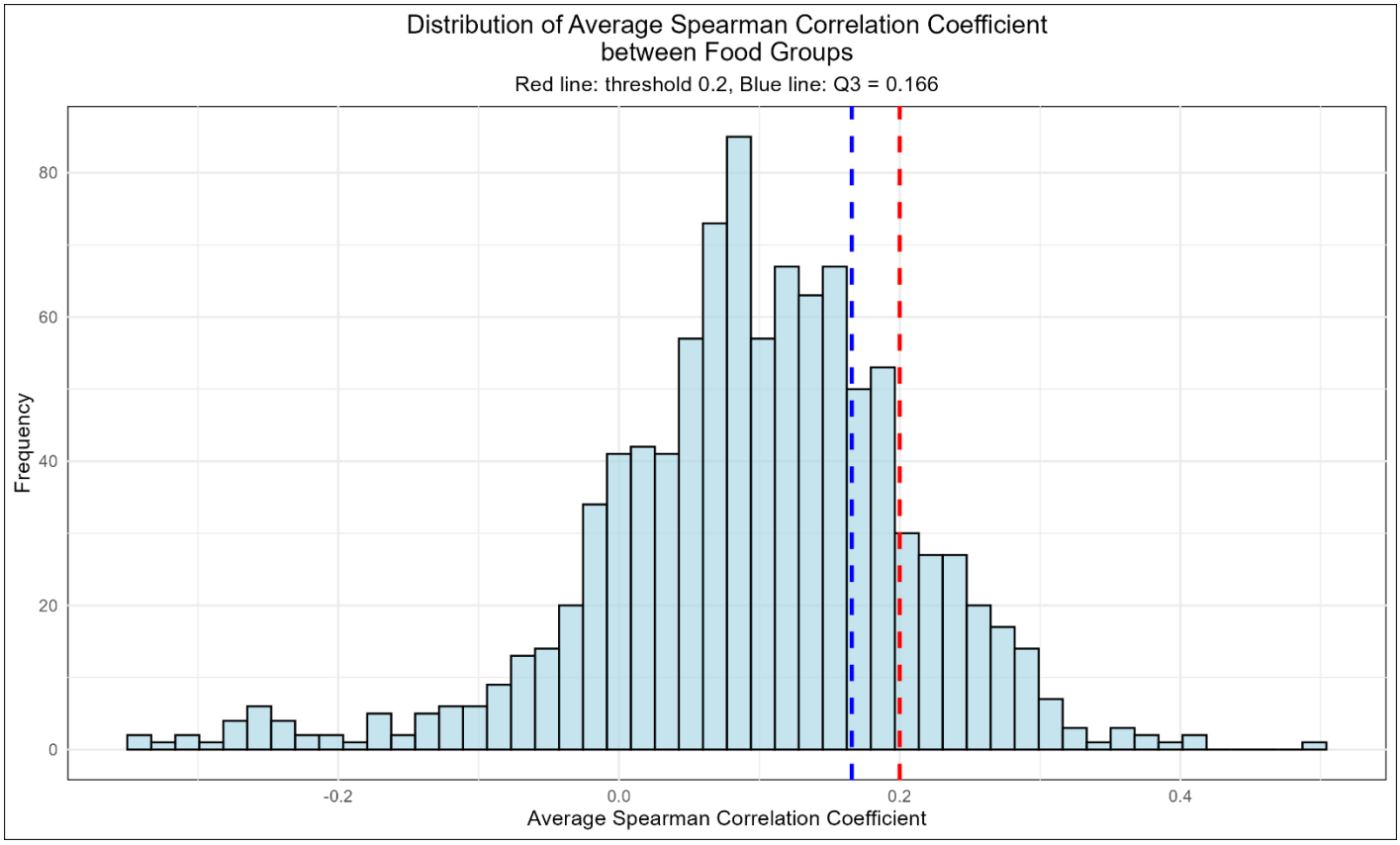
‡Non-native fruit referred to fruits not traditionally cultivated in Korea but imported for consumption.

**Supplementary Figure S2: Co-consumption Network Analysis Workflow**



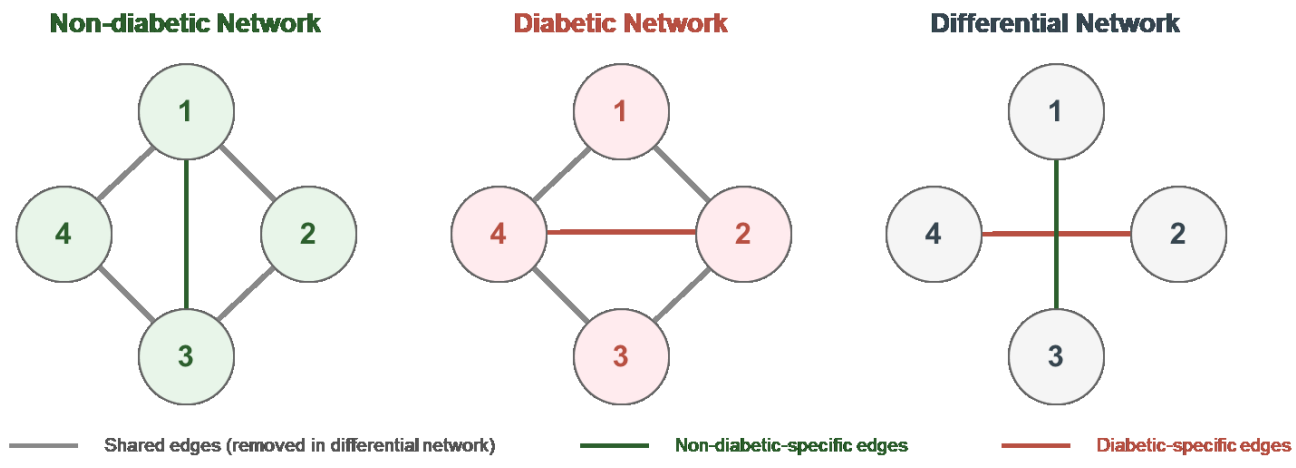
## Supplementary Figure S3: Distribution of energy and sex-adjusted partial correlation coefficients between food groups in CAVAS

Red dashed line indicates the network inclusion threshold (r = 0.2), blue dashed line shows the third quartile (Q3 = 0.166). Both distributions demonstrate that the 0.2 threshold appropriately captures correlations above the upper quartile, ensuring meaningful co-consumption relationships while maintaining methodological consistency across datasets.




## Supplementary Figure S4. Conceptual illustration of the differential co-consumption network

**The differential co-consumption network (D_CCN) is constructed by extracting edges that appear exclusively in either the non-diabetic or diabetic network, adapted from the approach proposed by Naghizadeh et al. [14]. Shared edges (gray) reflect common dietary background and are removed, isolating disease-specific co-consumption relationships**



**Supplementary Table 2**. Descriptive statistics and network centrality measures of 45 food groups by diabetes development status in CAVAS cohort

| Foods* (serving/day) | *Food Consumption Patterns* | | | | | *Network Centrality Indices* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean consumption | SD consumption | Median consumption | N consumers | Consumer percentage | Degree | Betweenness | Closeness | Eigenvector | Strength |
| ***NonDiabetic_Network (n=15,712)*** | | | | | | | | | | |
| *tRice* | 2.8 | 0.7 | 3 | 12,066 | 76.8 | 24 | 0.156 | 2.742 | 0.953 | 6.42 |
| *Noodles* | 0.2 | 0.2 | 0.1 | 11,859 | 75.5 | 2 | 0 | 1.652 | 0.08 | 0.53 |
| *DumplTeok* | 0 | 0.1 | 0 | 8,537 | 54.3 | 3 | 0.002 | 1.651 | 0.057 | 0.74 |
| *RiceCake* | 0 | 0.1 | 0 | 8,268 | 52.6 | 5 | 0.015 | 1.732 | 0.09 | 1.20 |
| *Cornflake* | 0 | 0 | 0 | 1,081 | 6.9 | 2 | 0 | 1.676 | 0.059 | 0.43 |
| *Bread* | 0.1 | 0.2 | 0 | 4,065 | 25.9 | 7 | 0.015 | 1.981 | 0.276 | 1.92 |
| *SwBread* | 0.1 | 0.2 | 0 | 8,205 | 52.2 | 8 | 0.017 | 2.079 | 0.249 | 2.21 |
| *Cheese/Fast* | 0 | 0.1 | 0 | 3,866 | 24.6 | 14 | 0.043 | 2.439 | 0.645 | 3.42 |
| *GrainPowder* | 0 | 0.1 | 0 | 4,114 | 26.2 | 0 | 0 | 0 | 0 | 0 |
| *Snacks* | 0.1 | 0.2 | 0 | 7,904 | 50.3 | 3 | 0.002 | 1.408 | 0.035 | 0.78 |
| *Nuts* | 0.2 | 0.3 | 0 | 7,930 | 50.5 | 8 | 0.033 | 2.165 | 0.372 | 1.91 |
| *SoySoup* | 0.5 | 0.5 | 0.3 | 11,789 | 75.0 | 5 | 0.002 | 1.633 | 0.096 | 1.14 |
| *TofuBeanspr* | 0.4 | 0.4 | 0.3 | 11,809 | 75.2 | 12 | 0.021 | 2.024 | 0.502 | 3.26 |
| *Egg* | 0.2 | 0.3 | 0.1 | 12,117 | 77.1 | 2 | 0 | 1.737 | 0.109 | 0.50 |
| *Starch* | 0 | 0.1 | 0 | 8,211 | 52.3 | 14 | 0.090 | 2.489 | 0.622 | 3.32 |
| *Potato* | 0.3 | 0.4 | 0.2 | 11,785 | 75.0 | 6 | 0.010 | 1.879 | 0.174 | 1.37 |
| *BaechuKimchi* | 2 | 1.1 | 1.8 | 11,809 | 75.2 | 1 | 0 | 1.169 | 0.007 | 0.31 |
| *OthKimchi* | 0.9 | 1.2 | 0.5 | 11,789 | 75.0 | 3 | 0.042 | 1.803 | 0.073 | 0.78 |
| *SaltFood* | 0.2 | 0.3 | 0.1 | 11,997 | 76.4 | 2 | 0 | 1.775 | 0.121 | 0.46 |
| *VegSoup* | 0.3 | 0.4 | 0.2 | 11,789 | 75.0 | 5 | 0.006 | 1.686 | 0.157 | 1.34 |
| *VegDish* | 0.5 | 0.7 | 0.3 | 11,784 | 75.0 | 23 | 0.170 | 2.647 | 1 | 6.57 |
| *Leaves* | 0.4 | 0.5 | 0.3 | 11,792 | 75.1 | 6 | 0.010 | 1.932 | 0.271 | 1.60 |
| *Mushroom* | 0.1 | 0.2 | 0 | 11,791 | 75.0 | 20 | 0.061 | 2.475 | 0.964 | 5.40 |
| *OthVeg* | 1.2 | 1.2 | 0.9 | 11,784 | 75.0 | 11 | 0.032 | 2.112 | 0.443 | 2.95 |
| *SwPumpkin* | 0 | 0.1 | 0 | 3,971 | 25.3 | 4 | 0 | 1.95 | 0.217 | 0.96 |
| *Poultry* | 0 | 0.1 | 0 | 8979 | 57.1 | 12 | 0.007 | 2.256 | 0.607 | 3.14 |
| *Bysprod* | 0 | 0 | 0 | 4911 | 31.3 | 8 | 0.013 | 1.896 | 0.315 | 1.85 |
| *Cuttlefish* | 0 | 0.1 | 0 | 8,505 | 54.1 | 12 | 0.013 | 2.309 | 0.592 | 2.91 |
| *Pork* | 0.1 | 0.2 | 0.1 | 11,867 | 75.5 | 7 | 0 | 1.954 | 0.371 | 1.92 |
| *ProcMeat/Sea* | 0.1 | 0.1 | 0 | 8,174 | 52.0 | 16 | 0.093 | 2.572 | 0.681 | 3.84 |
| *Beef* | 0.1 | 0.2 | 0 | 12,049 | 76.7 | 14 | 0 | 2.411 | 0.727 | 3.59 |
| *RawFish* | 0 | 0.1 | 0 | 7,861 | 50.0 | 15 | 0.035 | 2.423 | 0.747 | 3.88 |
| *DogMeat* | 0 | 0 | 0 | 4,015 | 25.6 | 2 | 0 | 1.584 | 0.074 | 0.45 |
| *Fish* | 0.3 | 0.4 | 0.2 | 11,816 | 75.2 | 12 | 0.021 | 2.166 | 0.645 | 3.24 |
| *Anchovy* | 0.3 | 0.4 | 0.2 | 11,867 | 75.5 | 6 | 0.005 | 1.716 | 0.173 | 1.50 |
| *Seaweed* | 0.5 | 0.5 | 0.4 | 11,787 | 75.0 | 9 | 0.004 | 2.072 | 0.416 | 2.34 |
| *Shellfish* | 0.1 | 0.2 | 0 | 7,996 | 50.9 | 15 | 0.017 | 2.326 | 0.781 | 4.03 |
| *Milk* | 0.5 | 0.6 | 0.3 | 11,883 | 75.6 | 2 | 0 | 1.645 | 0.149 | 0.61 |
| *Soda/Ice,* | 0.1 | 0.2 | 0 | 8,022 | 51.1 | 3 | 0.013 | 1.693 | 0.069 | 0.75 |
| *SoyMilk* | 0.1 | 0.2 | 0 | 3,961 | 25.2 | 0 | 0 | 0 | 0 | 0 |
| *Coffee* | 3.3 | 3.2 | 3 | 11,956 | 76.1 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *TradDrink* | 0.1 | 0.3 | 0 | 8,216 | 52.3 | 5 | 0 | 1.977 | 0.248 | 1.16 |
| *GTea* | 0.3 | 0.7 | 0 | 7,946 | 50.6 | 5 | 0.004 | 2.109 | 0.252 | 1.12 |
| *DomFruit* | 1.1 | 1 | 0.9 | 11,784 | 75.0 | 5 | 0 | 1.974 | 0.274 | 1.31 |
| *ImpFruit* | 0.1 | 0.2 | 0 | 11,988 | 76.3 | 16 | 0.089 | 2.547 | 0.661 | 3.92 |
| ***Diabetic_Network (n=953)*** | | | | | | | | | | |
| *tRice* | 2.9 | 0.7 | 3 | 721 | 75.7 | 25 | 0.163 | 2.751 | 1 | 6.44 |
| *Noodles* | 0.2 | 0.2 | 0.1 | 715 | 75.0 | 2 | 0 | 1.668 | 0.105 | 0.53 |
| *DumplTeok* | 0 | 0.1 | 0 | 479 | 50.3 | 7 | 0.015 | 2.039 | 0.248 | 1.63 |
| *RiceCake* | 0 | 0.1 | 0 | 488 | 51.2 | 4 | 0.001 | 1.689 | 0.129 | 0.95 |
| *Cornflake* | 0 | 0 | 0 | 37 | 3.9 | 0 | 0 | 0 | 0 | 0 |
| *Bread* | 0 | 0.2 | 0 | 247 | 25.9 | 11 | 0.060 | 2.097 | 0.491 | 2.90 |
| *SwBread* | 0.1 | 0.1 | 0 | 512 | 53.7 | 9 | 0.011 | 1.984 | 0.35 | 2.43 |
| *Cheese/Fast* | 0 | 0.1 | 0 | 148 | 15.5 | 9 | 0.005 | 2.093 | 0.452 | 2.18 |
| *GrainPowder* | 0 | 0.1 | 0 | 239 | 25.1 | 1 | 0 | 1.256 | 0.005 | 0.22 |
| *Snacks* | 0.1 | 0.2 | 0 | 524 | 55.0 | 3 | 0 | 1.384 | 0.098 | 0.89 |
| *Nuts* | 0.2 | 0.3 | 0 | 477 | 50.1 | 6 | 0.025 | 2.144 | 0.276 | 1.36 |
| *SoySoup* | 0.5 | 0.5 | 0.4 | 716 | 75.1 | 7 | 0.007 | 1.903 | 0.229 | 1.76 |
| *TofuBeanspr* | 0.4 | 0.5 | 0.3 | 715 | 75.0 | 14 | 0.063 | 2.254 | 0.549 | 3.56 |
| *Egg* | 0.2 | 0.2 | 0.1 | 720 | 75.6 | 4 | 0.007 | 1.988 | 0.183 | 0.91 |
| *Starch* | 0 | 0.1 | 0 | 490 | 51.4 | 12 | 0.042 | 2.291 | 0.57 | 2.88 |
| *Potato* | 0.3 | 0.4 | 0.2 | 717 | 75.2 | 7 | 0.004 | 1.919 | 0.221 | 1.57 |
| *BaechuKimchi* | 2 | 1.2 | 2 | 721 | 75.7 | 1 | 0 | 1.095 | 0.01 | 0.34 |
| *OthKimchi* | 1 | 1.4 | 0.5 | 719 | 75.4 | 3 | 0.043 | 1.721 | 0.087 | 0.82 |
| *SaltFood* | 0.2 | 0.4 | 0.1 | 721 | 75.7 | 5 | 0.018 | 2.148 | 0.258 | 1.10 |
| *VegSoup* | 0.3 | 0.4 | 0.2 | 727 | 76.3 | 6 | 0.004 | 1.745 | 0.206 | 1.56 |
| *VegDish* | 0.5 | 0.8 | 0.3 | 715 | 75.0 | 22 | 0.236 | 2.607 | 0.933 | 6.05 |
| *Leaves* | 0.4 | 0.5 | 0.3 | 715 | 75.0 | 7 | 0.007 | 1.762 | 0.265 | 1.81 |
| *Mushroom* | 0.1 | 0.2 | 0 | 492 | 51.6 | 16 | 0.047 | 2.265 | 0.829 | 4.32 |
| *OthVeg* | 1.3 | 1.2 | 1 | 715 | 75.0 | 11 | 0.006 | 2.112 | 0.495 | 3.01 |
| *SwPumpkin* | 0 | 0.2 | 0 | 241 | 25.3 | 3 | 0 | 1.858 | 0.193 | 0.73 |
| *Poultry* | 0 | 0 | 0 | 516 | 54.1 | 10 | 0.008 | 2.023 | 0.445 | 2.58 |
| *Bysprod* | 0 | 0.1 | 0 | 310 | 32.5 | 9 | 0.017 | 1.959 | 0.326 | 2.12 |
| *Cuttlefish* | 0 | 0.1 | 0 | 498 | 52.3 | 6 | 0.007 | 1.918 | 0.281 | 1.43 |
| *Pork* | 0.1 | 0.2 | 0.1 | 719 | 75.4 | 6 | 0 | 1.845 | 0.341 | 1.65 |
| *ProcMeat/Sea* | 0.1 | 0.1 | 0 | 495 | 51.9 | 18 | 0.056 | 2.474 | 0.796 | 4.66 |
| *Beef* | 0.1 | 0.2 | 0 | 716 | 75.1 | 13 | 0.027 | 2.391 | 0.679 | 3.35 |
| *RawFish* | 0 | 0.1 | 0 | 478 | 50.2 | 13 | 0.044 | 2.292 | 0.6 | 3.29 |
| *DogMeat* | 0 | 0.2 | 0 | 248 | 26.0 | 2 | 0 | 1.521 | 0.074 | 0.48 |
| *Fish* | 0.3 | 0.5 | 0.2 | 715 | 75.0 | 11 | 0.034 | 2.212 | 0.538 | 2.77 |
| *Anchovy* | 0.3 | 0.4 | 0.2 | 715 | 75.0 | 7 | 0.004 | 1.689 | 0.218 | 1.79 |
| *Seaweed* | 0.5 | 0.6 | 0.3 | 715 | 75.0 | 8 | 0 | 2.135 | 0.408 | 2.09 |
| *Shellfish* | 0.1 | 0.2 | 0 | 483 | 50.7 | 14 | 0.022 | 2.341 | 0.689 | 3.54 |
| *Milk* | 0.5 | 0.6 | 0.2 | 728 | 76.4 | 2 | 0 | 1.626 | 0.164 | 0.59 |
| *Soda/Ice,* | 0.1 | 0.3 | 0 | 518 | 54.4 | 4 | 0 | 1.675 | 0.162 | 1.06 |
| *SoyMilk* | 0.1 | 0.2 | 0 | 259 | 27.2 | 2 | 0.043 | 1.734 | 0.064 | 0.43 |
| *Coffee* | 3.3 | 3.3 | 3 | 715 | 75.0 | 0 | 0 | 0 | 0 | 0 |
| *TradDrink* | 0.1 | 0.3 | 0 | 484 | 50.8 | 5 | 0 | 1.922 | 0.263 | 1.21 |
| *GTea* | 0.3 | 0.8 | 0 | 479 | 50.3 | 5 | 0.002 | 2.040 | 0.265 | 1.22 |
| *DomFruit* | 1.1 | 0.9 | 0.9 | 715 | 75.0 | 6 | 0.003 | 1.820 | 0.312 | 1.67 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *ImpFruit* | 0.1 | 0.2 | 0 | 490 | 51.4 | 14 | 0.075 | 2.308 | 0.617 | 3.47 |

* Values for mean, standard deviation and median consumption are expressed as servings/day. Consumer numbers represent participants classified as consumers based on binarized food intake data (see Methods). Network centrality indices are dimensionless measures derived from co-consumption correlation networks.