**Supplementary Material 1.** Participant flowchart for adults with 1d of valid dietary data in NNPAS 2011-12.

Individuals who participated in the NNPAS (*n*=12,153)

Individuals younger than 19 years old were excluded (*n*=2812)

NNPAS participants aged ≥19 years (*n*=9341)

Individuals with a Goldberg cut-off of <0.9 (n=2043)

NNPAS participants aged ≥19 years who had valid dietary recall data (*n*=7298)

*n* participants vary by outcome (range=1982 to 6003)

**Supplementary Material 2.** All UPF items in the AUSNUT 2011-13 Nova database that contain ≥25% whole grain per 100g dry weight.

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| **Category Code** | **Category Label** |
| 12101022 | Quinoa, cooked in water & fat (margarine), no added salt |
| 12207003 | Bread, from wholemeal flour, commercial |
| 12207004 | Bread, from wholemeal flour, commercial, toasted |
| 12208001 | Bread, from wholemeal flour, commercial, added fibre |
| 12208002 | Bread, from wholemeal flour, commercial, added fibre, toasted |
| 12208003 | Bread, from wholemeal flour, commercial, added fibre & vitamins B1, B3, B6 & E, Fe & Zn |
| 12208004 | Bread, from wholemeal flour, commercial, added fibre & vitamins B1, B3, B6 & E, Fe & Zn, toasted |
| 12208005 | Bread, from wholemeal flour, commercial, added iron |
| 12208006 | Bread, from wholemeal flour, commercial, added iron, toasted |
| 12208007 | Bread, from wholemeal flour, commercial, added omega-3 polyunsaturates |
| 12208008 | Bread, from wholemeal flour, commercial, added omega-3 polyunsaturates, toasted |
| 12209001 | Bread, damper, from wholemeal flour, homemade from basic ingredients |
| 12210003 | Bread, from rye flour, light, commercial |
| 12210004 | Bread, from rye flour, light, commercial, toasted |
| 12214008 | Bread roll, for use in subway sandwich recipes |
| 12301004 | Muffin, English style, from wholemeal flour, commercial, toasted |
| 12307002 | Bread, garlic or herb, homemade, cooked |
| 12307004 | French toast, wholemeal bread, plain |
| 12503001 | Breakfast cereal, puffed or popped rice, no added sugar or salt, unfortified |
| 12505001 | Breakfast cereal, wheat bran, flakes, unfortified |
| 12505002 | Breakfast cereal, whole wheat, biscuit, no added sugar or salt, unfortified |
| 12505003 | Breakfast cereal, whole wheat, biscuit, no added sugar, unfortified |
| 12505004 | Breakfast cereal, whole wheat, biscuit, added sugar & salt, unfortified |
| 12505005 | Breakfast cereal, whole wheat, flakes, no added sugar, unfortified |
| 12505006 | Breakfast cereal, whole wheat, puffed, no added sugar or salt, unfortified |
| 12506001 | Breakfast cereal, wheat bran, flakes, added vitamins B1, B2 B3, B6, & folate, Fe & Zn |
| 12506007 | Breakfast cereal, whole wheat, biscuit, added vitamins B1, B2 & B3 |
| 12506008 | Breakfast cereal, whole wheat, biscuit, added vitamins B1, B2 & B3, Ca, Fe & Zn |
| 12506009 | Breakfast cereal, whole wheat, biscuit, added vitamins B1, B2, B3 & folate, Fe & Zn |
| 12506010 | Breakfast cereal, whole wheat, biscuit, bran, added vitamins B1, B2, B3 & folate & Fe |
| 12506011 | Breakfast cereal, whole wheat, biscuit, not further defined |
| 12506012 | Breakfast cereal, whole wheat, flakes, added vitamins B1, B2, B3 & folate |
| 12506013 | Breakfast cereal, whole wheat, flakes, added vitamins B1, B2, B3, C & folate & Fe |
| 12506014 | Breakfast cereal, whole wheat, small biscuit, added vitamins B1, B2, B3 & folate |
| 12506015 | Breakfast cereal, wheat based, commercial, not further defined |
| 12507002 | Breakfast cereal, whole wheat, small biscuit, with honey, added vitamins B1, B2, B3 & folate, Fe & Zn |
| 12508001 | Breakfast cereal, whole wheat, flakes, added dried fruit &/or nuts, no added sugar, unfortified |
| 12509001 | Breakfast cereal, wheat bran, flakes, sultanas, added vitamins B1, B2, B3, B6 & folate, Fe & Zn |
| 12509002 | Breakfast cereal, whole wheat, small biscuit, with apricot, added vitamins B1, B2, B3 & folate, Ca & Fe |
| 12509003 | Breakfast cereal, whole wheat, small biscuit, with berries, added vitamins B1, B2, B3 & folate, Ca & Fe |
| 12509004 | Breakfast cereal, whole wheat, small biscuit, with blackcurrant paste, added vitamins B1, B2, B3 & folate |
| 12509005 | Breakfast cereal, whole wheat, small biscuit, with fruit paste, added vitamins B1, B2, B3 & C & Fe |
| 12509006 | Breakfast cereal, whole wheat, flakes, dried fruit, added vitamins B1, B2, B3, C & folate |
| 12509007 | Breakfast cereal, whole wheat, flakes, dried fruit & nuts, added fibre, vitamins B1, B2, B3 & folate, Ca & Fe |
| 12510001 | Breakfast cereal, wheat bran, flakes, honey & almond, added vitamins B1, B2 B3, B6 & folate, Fe & Zn |
| 12510002 | Breakfast cereal, wheat bran, flakes, sultanas, added vitamins B1, B2, B3 & folate & Fe |
| 12511001 | Breakfast cereal, mixed grain (barley & soy), flakes, honey, unfortified |
| 12511002 | Breakfast cereal, mixed grain (wheat & corn), flakes or extruded, no added salt, unfortified |
| 12511004 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, honey, unfortified |
| 12511005 | Breakfast cereal, oat & whole wheat, biscuit, added salt, unfortified |
| 12512002 | Breakfast cereal, mixed grain (wheat, oat, rice & corn), clusters, added vitamins B1, B2, B3, C & folate, Fe & Zn |
| 12512003 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), extruded, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12512005 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, honey, added vitamins B1, B2, B3 & folate & Fe |
| 12512006 | Breakfast cereal, whole wheat, biscuit, multigrain, added vitamins B1, B2, B3 & E & Fe |
| 12513001 | Breakfast cereal, mixed grain (wheat & corn), extruded, chocolate malt coating, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12513003 | Breakfast cereal, mixed grain (wheat, oat & corn), extruded, added vitamins B1, B2, B3, B6, C & folate, Fe & Zn |
| 12513004 | Breakfast cereal, mixed grain (wheat, oat & corn), extruded, added vitamins B1, B2, B3, B6, C & folate, Ca, Fe & Zn |
| 12513006 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), extruded, honey, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12513007 | Breakfast cereal, mixed grain (wheat, oat & corn), extruded, cocoa coating, added B1, B2, B3, B6, C & folate, Ca, Fe & Zn |
| 12513008 | Breakfast cereal, mixed grain (wheat, corn & rice), extruded, cocoa coating, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe, Mg & Zn |
| 12514001 | Breakfast cereal, mixed grain (barley & oat), flakes, honey, added fruit, nuts & seeds, unfortified |
| 12514002 | Breakfast cereal, mixed grain (wheat & oat), flakes, dried fruit, no added salt, unfortified |
| 12514003 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, dried fruit, no added salt, unfortified |
| 12514004 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, cashew, almond, hazelnut & coconut, unfortified |
| 12514005 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes & clusters, apple & raisins, unfortified |
| 12514006 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, added fruit &/or nuts, no added salt, unfortified |
| 12514007 | Muesli, commercial, gluten free |
| 12514008 | Muesli, commercial, toasted, added dried fruit, unfortified |
| 12514009 | Muesli, commercial, toasted, added dried fruit & nuts, unfortified |
| 12514010 | Muesli, commercial, toasted, added nuts, unfortified |
| 12515003 | Breakfast cereal, mixed grain (rice & wheat), flakes, nuts, added vitamins B1, B2 & B3, Ca & Fe |
| 12515004 | Breakfast cereal, mixed grain (wheat & corn), flakes, berries & sultanas, added vitamins A, B1, B2, B3, B6, E & folate, Ca, Fe & Zn |
| 12515005 | Breakfast cereal, mixed grain (wheat & corn), flakes, sultana, apple & currant, added vitamins B1, B2, B3, B6, E & folate, Ca, Fe & Zn |
| 12515006 | Breakfast cereal, mixed grain (wheat & oat), clusters, almond, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12515007 | Breakfast cereal, mixed grain (wheat & oat), flakes, apple, sultana & cranberry, added vitamins B1, B2, B3, B6, C, E & folate |
| 12515008 | Breakfast cereal, mixed grain (wheat & oat), flakes, apricot & sultana, added vitamins B1, B2, B3 & folate & Fe |
| 12515009 | Breakfast cereal, mixed grain (wheat & oat), flakes, berries, added vitamins B1, B2, B3 & folate & Fe |
| 12515011 | Breakfast cereal, mixed grain (wheat, oat & corn), flakes, fruit, added vitamins B1, B2, B3, B6, E & folate, Ca, Fe & Zn |
| 12515012 | Breakfast cereal, mixed grain (wheat, oat & corn), flakes, fruit & nuts, added vitamins B1, B2, B3, C & folate & Fe |
| 12515013 | Breakfast cereal, mixed grain (wheat, oat & corn), flakes, fruit & nuts, added vitamins B1, B2, B3, B6, E & folate, Ca, Fe & Zn |
| 12515014 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes & clusters, apple, added vitamins B1, B2, B3, B6, E & folate, Fe & Zn |
| 12515015 | Breakfast cereal, mixed grain (wheat, oat & corn), flakes & clusters, pomegranate & berries, added vitamins A, B1, B2, B3, B6, E & folate, Ca, Fe & Zn |
| 12515016 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes & clusters, sultanas, added vitamins B1, B2, B3, B6, C & folate, Fe & Zn |
| 12515017 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, dried fruit, added vitamins B1, B2, B3 & E & Fe |
| 12515018 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), clusters, apple & almonds, added vitamins B1, B2, B3 & folate & Fe |
| 12515019 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), clusters, sultana & berries, added vitamins B1, B2, B3, E & folate, Ca & Fe |
| 12515020 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes & clusters, honey & macadamias, added vitamins B1, B2, B3, E & folate, Ca & Fe |
| 12515021 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, apricot & coconut, added vitamins B1, B2, B3, E & folate, Ca & Fe |
| 12515022 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, berries, added vitamins B1, B2, B3, E & folate, Ca & Fe |
| 12515023 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, fruit, added vitamins B1, B2, B3 & folate & Fe |
| 12515024 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, fruit, added vitamins B1, B2, B3, & folate, Ca & Fe |
| 12515025 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, fruit & nuts, added vitamins B1, B2, B3, C & folate & Fe |
| 12515026 | Breakfast cereal, mixed grain, commercial, not further defined |
| 12515027 | Muesli, commercial, toasted, added dried fruit & nuts, added vitamins B2, B3, E & folate & Ca |
| 12516001 | Breakfast cereal, barley, flakes, honey, added sultanas, unfortified |
| 12516003 | Breakfast cereal, not further defined |
| 12601006 | Porridge, rolled oats, prepared with rice milk |
| 12601007 | Porridge, rolled oats, prepared with soy milk |
| 12601009 | Porridge, rolled oats, prepared with soy milk & water |
| 12601011 | Porridge, rolled oats mixed with sugar or honey & other flavours, prepared with water |
| 12601012 | Porridge, rolled oats mixed with sugar or honey & other flavours, prepared with cows milk |
| 12601013 | Porridge, rolled oats mixed with sugar or honey & other flavours, prepared with soy milk |
| 12601016 | Porridge, rolled oats mixed with sugar, flavours & dried fruit, prepared with soy milk |
| 12601017 | Oats, rolled, mixed with sugar or honey & other flavours, uncooked |
| 12601018 | Oats, rolled, mixed with sugar, flavours & dried fruit, uncooked |
| 13201008 | Biscuit, savoury, from wholemeal wheat flour |
| 13201009 | Biscuit, savoury, from wholemeal wheat flour, added grains |
| 13201010 | Biscuit, savoury, from wholemeal wheat flour, crispbread |
| 13201011 | Biscuit, savoury, from wholemeal wheat flour, Salada style, high fibre |
| 13203001 | Biscuit, savoury, from rye flour, crispbread |
| 13203002 | Biscuit, savoury, from rye flour, crispbread, with added grains (buckwheat, linseed, soy, sesame) |
| 13204001 | Biscuit, savoury, rice cake, from brown rice, plain |
| 13204002 | Biscuit, savoury, rice cake, from brown rice, flavoured |
| 13204003 | Biscuit, savoury, rice cake, from brown rice, carob coated |
| 13204009 | Biscuit, savoury, rice cracker, from brown rice, all flavours |
| 13307010 | Scone, wholemeal, commercial |
| 13307011 | Scone, wholemeal, homemade from basic ingredients |
| 13401021 | Pastry, shortcrust, wholemeal, commercial, raw |
| 13401022 | Pastry, shortcrust, wholemeal, commercial, baked |
| 13503022 | Filled bread roll, commercial, ham, oil based sauce |
| 13503056 | Sandwich or roll, filled with ham |
| 13503059 | Sandwich or roll, filled with ham & tomato, toasted |
| 13503066 | Sandwich or roll, filled with vegemite |
| 13507005 | Mexican nachos, corn chips, with salsa |
| 13511004 | Rice, brown, fried, no meat or vegetables, oil not further defined, homemade |
| 13511005 | Rice, brown, fried with bacon or ham, egg & mixed vegetables |
| 13511006 | Rice, brown, fried with chicken, egg & mixed vegetables |
| 13511007 | Rice, brown, fried with mixed vegetables |
| 13601003 | Crepe or pancake, buckwheat flour, homemade from basic ingredients |
| 13601013 | Crepe or pancake, wholemeal wheat flour, commercial or homemade |
| 13606003 | Crumpet, from wholemeal flour, commercial, toasted |
| 20106002 | Milk, oat, fluid, unfortified |
| 20106003 | Milk, oat, fluid, added calcium |
| 20106004 | Milk, rice, fluid, added calcium |
| 20106005 | Milk, rice, fluid, protein enriched, added calcium |
| 26201001 | Corn chips, cheese flavoured, salted |
| 26201002 | Corn chips, other flavours, salted |
| 26201003 | Corn chips, plain, toasted, no added salt |
| 26201004 | Corn chips, plain toasted, salted |
| 26201006 | Corn chips, not further defined |
| 26202002 | Popcorn, commercial, butter flavoured, salted |
| 26202003 | Popcorn, microwaved, butter flavoured, salted |
| 26202004 | Popcorn, regular, unflavoured, salted, vegetable oil |
| 26202005 | Popcorn, regular, unflavoured, unsalted, vegetable oil |
| 26202006 | Popcorn, commercial, sugar coating |
| 26301004 | Grain waves wheat snack, plain, original |
| 26301005 | Grain waves wheat snack, cheese or sour cream & chives |
| 26301006 | Grain waves wheat snack, other flavours |
| 28302001 | Bar, muesli or snack, plain or with 10% dried fruit |
| 28302002 | Bar, muesli or snack, plain or with 10% dried fruit, added vitamins B1, B2, B3, folate & Fe |
| 28302003 | Bar, muesli or snack, plain or with 10% dried fruit, high fibre, added vitamins B1, B2, B3, B6, E, & folate, Fe & Zn |
| 28302004 | Bar, muesli or snack, with 10% dried fruit & 5% nuts |
| 28302005 | Bar, muesli or snack, with 10% dried fruit & 10% nuts |
| 28302010 | Bar, muesli or snack, with 20% dried fruit & 5% nuts |
| 28302012 | Bar, muesli or snack, with 30% dried fruit & 30% nuts |
| 28302013 | Bar, muesli or snack, with 10% nuts |
| 28302014 | Bar, muesli or snack, with 10% nuts, added flaxseeds |
| 28302021 | Bar, muesli or snack, not further defined |
| 28303002 | Bar, muesli or snack, plain or with 10% dried fruit, yoghurt-coated |
| 28303004 | Bar, muesli or snack, with 15% dried fruit & 15% nuts, yoghurt-coated |
| 28303006 | Bar, muesli or snack, with 10% nuts, chocolate-coated |
| 28303007 | Bar, muesli or snack, with chocolate chips or coating |

**Supplementary Material 3**. All UPF items in the AUSNUT 2011-13 Nova database that contain ≥50% whole grain per 100g dry weight.

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| **Category Code** | **Category Label** |
| 12101022 | Quinoa, cooked in water & fat (margarine), no added salt |
| 12207003 | Bread, from wholemeal flour, commercial |
| 12207004 | Bread, from wholemeal flour, commercial, toasted |
| 12208001 | Bread, from wholemeal flour, commercial, added fibre |
| 12208002 | Bread, from wholemeal flour, commercial, added fibre, toasted |
| 12208003 | Bread, from wholemeal flour, commercial, added fibre & vitamins B1, B3, B6 & E, Fe & Zn |
| 12208004 | Bread, from wholemeal flour, commercial, added fibre & vitamins B1, B3, B6 & E, Fe & Zn, toasted |
| 12208005 | Bread, from wholemeal flour, commercial, added iron |
| 12208006 | Bread, from wholemeal flour, commercial, added iron, toasted |
| 12208007 | Bread, from wholemeal flour, commercial, added omega-3 polyunsaturates |
| 12208008 | Bread, from wholemeal flour, commercial, added omega-3 polyunsaturates, toasted |
| 12209001 | Bread, damper, from wholemeal flour, homemade from basic ingredients |
| 12301004 | Muffin, English style, from wholemeal flour, commercial, toasted |
| 12307004 | French toast, wholemeal bread, plain |
| 12503001 | Breakfast cereal, puffed or popped rice, no added sugar or salt, unfortified |
| 12505001 | Breakfast cereal, wheat bran, flakes, unfortified |
| 12505002 | Breakfast cereal, whole wheat, biscuit, no added sugar or salt, unfortified |
| 12505003 | Breakfast cereal, whole wheat, biscuit, no added sugar, unfortified |
| 12505004 | Breakfast cereal, whole wheat, biscuit, added sugar & salt, unfortified |
| 12505005 | Breakfast cereal, whole wheat, flakes, no added sugar, unfortified |
| 12505006 | Breakfast cereal, whole wheat, puffed, no added sugar or salt, unfortified |
| 12506001 | Breakfast cereal, wheat bran, flakes, added vitamins B1, B2 B3, B6, & folate, Fe & Zn |
| 12506007 | Breakfast cereal, whole wheat, biscuit, added vitamins B1, B2 & B3 |
| 12506008 | Breakfast cereal, whole wheat, biscuit, added vitamins B1, B2 & B3, Ca, Fe & Zn |
| 12506009 | Breakfast cereal, whole wheat, biscuit, added vitamins B1, B2, B3 & folate, Fe & Zn |
| 12506010 | Breakfast cereal, whole wheat, biscuit, bran, added vitamins B1, B2, B3 & folate & Fe |
| 12506011 | Breakfast cereal, whole wheat, biscuit, not further defined |
| 12506012 | Breakfast cereal, whole wheat, flakes, added vitamins B1, B2, B3 & folate |
| 12506013 | Breakfast cereal, whole wheat, flakes, added vitamins B1, B2, B3, C & folate & Fe |
| 12506014 | Breakfast cereal, whole wheat, small biscuit, added vitamins B1, B2, B3 & folate |
| 12507002 | Breakfast cereal, whole wheat, small biscuit, with honey, added vitamins B1, B2, B3 & folate, Fe & Zn |
| 12508001 | Breakfast cereal, whole wheat, flakes, added dried fruit &/or nuts, no added sugar, unfortified |
| 12509002 | Breakfast cereal, whole wheat, small biscuit, with apricot, added vitamins B1, B2, B3 & folate, Ca & Fe |
| 12509003 | Breakfast cereal, whole wheat, small biscuit, with berries, added vitamins B1, B2, B3 & folate, Ca & Fe |
| 12509004 | Breakfast cereal, whole wheat, small biscuit, with blackcurrant paste, added vitamins B1, B2, B3 & folate |
| 12509005 | Breakfast cereal, whole wheat, small biscuit, with fruit paste, added vitamins B1, B2, B3 & C & Fe |
| 12509006 | Breakfast cereal, whole wheat, flakes, dried fruit, added vitamins B1, B2, B3, C & folate |
| 12509007 | Breakfast cereal, whole wheat, flakes, dried fruit & nuts, added fibre, vitamins B1, B2, B3 & folate, Ca & Fe |
| 12510002 | Breakfast cereal, wheat bran, flakes, sultanas, added vitamins B1, B2, B3 & folate & Fe |
| 12511001 | Breakfast cereal, mixed grain (barley & soy), flakes, honey, unfortified |
| 12511004 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, honey, unfortified |
| 12511005 | Breakfast cereal, oat & whole wheat, biscuit, added salt, unfortified |
| 12512002 | Breakfast cereal, mixed grain (wheat, oat, rice & corn), clusters, added vitamins B1, B2, B3, C & folate, Fe & Zn |
| 12512003 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), extruded, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12512006 | Breakfast cereal, whole wheat, biscuit, multigrain, added vitamins B1, B2, B3 & E & Fe |
| 12513001 | Breakfast cereal, mixed grain (wheat & corn), extruded, chocolate malt coating, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12513006 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), extruded, honey, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12513008 | Breakfast cereal, mixed grain (wheat, corn & rice), extruded, cocoa coating, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe, Mg & Zn |
| 12514001 | Breakfast cereal, mixed grain (barley & oat), flakes, honey, added fruit, nuts & seeds, unfortified |
| 12514002 | Breakfast cereal, mixed grain (wheat & oat), flakes, dried fruit, no added salt, unfortified |
| 12514003 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, dried fruit, no added salt, unfortified |
| 12514004 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, cashew, almond, hazelnut & coconut, unfortified |
| 12514005 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes & clusters, apple & raisins, unfortified |
| 12514006 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, added fruit &/or nuts, no added salt, unfortified |
| 12514008 | Muesli, commercial, toasted, added dried fruit, unfortified |
| 12514009 | Muesli, commercial, toasted, added dried fruit & nuts, unfortified |
| 12514010 | Muesli, commercial, toasted, added nuts, unfortified |
| 12515003 | Breakfast cereal, mixed grain (rice & wheat), flakes, nuts, added vitamins B1, B2 & B3, Ca & Fe |
| 12515006 | Breakfast cereal, mixed grain (wheat & oat), clusters, almond, added vitamins B1, B2, B3, B6, C, E & folate, Ca, Fe & Zn |
| 12515008 | Breakfast cereal, mixed grain (wheat & oat), flakes, apricot & sultana, added vitamins B1, B2, B3 & folate & Fe |
| 12515009 | Breakfast cereal, mixed grain (wheat & oat), flakes, berries, added vitamins B1, B2, B3 & folate & Fe |
| 12515015 | Breakfast cereal, mixed grain (wheat, oat & corn), flakes & clusters, pomegranate & berries, added vitamins A, B1, B2, B3, B6, E & folate, Ca, Fe & Zn |
| 12515017 | Breakfast cereal, mixed grain (wheat, rice & oat), flakes, dried fruit, added vitamins B1, B2, B3 & E & Fe |
| 12515018 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), clusters, apple & almonds, added vitamins B1, B2, B3 & folate & Fe |
| 12515020 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes & clusters, honey & macadamias, added vitamins B1, B2, B3, E & folate, Ca & Fe |
| 12515022 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, berries, added vitamins B1, B2, B3, E & folate, Ca & Fe |
| 12515024 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, fruit, added vitamins B1, B2, B3, & folate, Ca & Fe |
| 12515025 | Breakfast cereal, mixed grain (wheat, corn, rice & oat), flakes, fruit & nuts, added vitamins B1, B2, B3, C & folate & Fe |
| 12515027 | Muesli, commercial, toasted, added dried fruit & nuts, added vitamins B2, B3, E & folate & Ca |
| 12516001 | Breakfast cereal, barley, flakes, honey, added sultanas, unfortified |
| 12516003 | Breakfast cereal, not further defined |
| 12601006 | Porridge, rolled oats, prepared with rice milk |
| 12601007 | Porridge, rolled oats, prepared with soy milk |
| 12601009 | Porridge, rolled oats, prepared with soy milk & water |
| 12601011 | Porridge, rolled oats mixed with sugar or honey & other flavours, prepared with water |
| 12601012 | Porridge, rolled oats mixed with sugar or honey & other flavours, prepared with cows milk |
| 12601013 | Porridge, rolled oats mixed with sugar or honey & other flavours, prepared with soy milk |
| 12601016 | Porridge, rolled oats mixed with sugar, flavours & dried fruit, prepared with soy milk |
| 12601017 | Oats, rolled, mixed with sugar or honey & other flavours, uncooked |
| 12601018 | Oats, rolled, mixed with sugar, flavours & dried fruit, uncooked |
| 13201010 | Biscuit, savoury, from wholemeal wheat flour, crispbread |
| 13203001 | Biscuit, savoury, from rye flour, crispbread |
| 13203002 | Biscuit, savoury, from rye flour, crispbread, with added grains (buckwheat, linseed, soy, sesame) |
| 13204001 | Biscuit, savoury, rice cake, from brown rice, plain |
| 13204002 | Biscuit, savoury, rice cake, from brown rice, flavoured |
| 13204003 | Biscuit, savoury, rice cake, from brown rice, carob coated |
| 13204009 | Biscuit, savoury, rice cracker, from brown rice, all flavours |
| 13307010 | Scone, wholemeal, commercial |
| 13307011 | Scone, wholemeal, homemade from basic ingredients |
| 13401021 | Pastry, shortcrust, wholemeal, commercial, raw |
| 13401022 | Pastry, shortcrust, wholemeal, commercial, baked |
| 13511004 | Rice, brown, fried, no meat or vegetables, oil not further defined, homemade |
| 13511005 | Rice, brown, fried with bacon or ham, egg & mixed vegetables |
| 13511006 | Rice, brown, fried with chicken, egg & mixed vegetables |
| 13511007 | Rice, brown, fried with mixed vegetables |
| 13601003 | Crepe or pancake, buckwheat flour, homemade from basic ingredients |
| 13601013 | Crepe or pancake, wholemeal wheat flour, commercial or homemade |
| 20106002 | Milk, oat, fluid, unfortified |
| 20106003 | Milk, oat, fluid, added calcium |
| 20106004 | Milk, rice, fluid, added calcium |
| 20106005 | Milk, rice, fluid, protein enriched, added calcium |
| 26202002 | Popcorn, commercial, butter flavoured, salted |
| 26202003 | Popcorn, microwaved, butter flavoured, salted |
| 26202004 | Popcorn, regular, unflavoured, salted, vegetable oil |
| 26202005 | Popcorn, regular, unflavoured, unsalted, vegetable oil |
| 26301004 | Grain waves wheat snack, plain, original |
| 26301005 | Grain waves wheat snack, cheese or sour cream & chives |
| 26301006 | Grain waves wheat snack, other flavours |
| 28302001 | Bar, muesli or snack, plain or with 10% dried fruit |
| 28302002 | Bar, muesli or snack, plain or with 10% dried fruit, added vitamins B1, B2, B3, folate & Fe |
| 28302010 | Bar, muesli or snack, with 20% dried fruit & 5% nuts |
| 28302013 | Bar, muesli or snack, with 10% nuts |

**Supplementary Material 4.** Description of covariates included in characteristic and cardiometabolic risk measure regression analyses.

Covariates include:

* Age: participants age in years.
* Sex: male or female.
* Nutrient intakes: energy (kJ/d), fibre (g/d), sodium (mg/d), saturated fat intake (g/d), polyunsaturated fat intake (g/d), monounsaturated fat intake (g/d), trans fat intake (mg/d), and free sugar intake (% energy).
* Alcohol intake (g/day).
* Smoking status: current daily, current weekly (at least once weekly but not daily), current less than weekly, ex-smoker, or never smoked.
* Education level: postgraduate degree, graduate diploma, bachelor’s degree, advanced diploma, certificate iii/iv, certificate i/ii, undefined certificate, or no non-school qualification.
* Physical activity level: high, moderate, low, sedentary (very low), or sedentary (no exercise).
* Country of birth: Australia, or other.
* Remoteness area categories from the Australian Statistical Geography Standard (ASGS) 2016 [39]: major cities of Australia, inner regional Australia, or other.
* National Index of Relative Socio-economic Disadvantage 2011 (SEIFA) [40]: decile 1 – lowest to decile 10 – highest.

**A graph of a graph showing the amount of cholesterol in the intake

Description automatically generatedA graph of a graph showing the difference between a body weight and a body weight

Description automatically generatedA graph of a graph showing a line

Description automatically generated with medium confidenceA graph of a number of blood pressure

Description automatically generated with medium confidenceA graph of a graph showing the amount of blood pressure

Description automatically generatedA graph showing the growth of a person's body

Description automatically generated with medium confidenceA graph with a line

Description automatically generatedA graph of a graph showing the difference between energy and a source of energy

Description automatically generated with medium confidenceSupplementary Material 5.** Slopes of associations between quintiles of UPF energy intake (%) and mean (SD) for each cardiometabolic risk measure across all approaches.

**A graph of a graph with red lines

Description automatically generated with medium confidenceA graph of a graph with different colored lines

Description automatically generatedA graph of a number of individuals

Description automatically generated with medium confidenceA graph of a graph showing the amount of blood glucose in the intake

Description automatically generated with medium confidenceA graph with red line and green line

Description automatically generatedA graph of a graph with lines and numbers

Description automatically generated with medium confidenceA graph of a number of patients

Description automatically generated with medium confidence**

**Supplementary Material 6.** Whole grain and nutrient intakes, and characteristics of participants in NNPAS 2011-12 by quintiles of proportion of energy from ultra-processed foods according to the Nova UPF definition (Approach 1), and when foods ≥25% and ≥50% whole grain were excluded from this definition (Approach 2 and 3, respectively) (19+ years) (n= 2448).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Proportion of energy from UPF (%)** | | | | | p-value† |
|  | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** |
| **Approach 1** | | | | | | |
| n | 521 | 519 | 492 | 454 | 462 | - |
| Median proportion of energy from UPF (%) (IQR) | 28.9 (20.7-35.6) | 47.3 (43.4-49.9) | 58.9 (56.3-61.9) | 70.2 (67.1-73.2) | 84.8 (80.5-90.1) | - |
| Median proportion of energy from ≥25% WG UPF (%)(IQR) | 0 (0-3.6) | 0 (0-7.6) | 0 (0-6.9) | 0 (0-6.9) | 0 (0-7.4) | - |
| Median proportion of energy from ≥50% WG UPF (%)(IQR) | 0 (0-1.9) | 0 (0-5.8) | 0 (0-5.1) | 0 (0-4.6) | 0 (0-5.7) | - |
| Median whole-grain intake (g/10MJ/day) (IQR) | 36.9 (0-82.3) | 39.2 (9.2-68.7) | 36.0 (5.6-66.3) | 24.9 (0-52.7) | 11.6 (0-39.7) | - |
| Age‡§ | 48.6(1.2)B | 46.7(1.0)B | 43.7(1.2)AB | 40.7(1.3)A | 39.2(1.1)A | <0.0001 |
| Female (%)‖‖ | 52.2(2.7)A | 51.0(3.6)A | 51.2(4.3)A | 44.7(3.8)A | 49.4(3.2)A | 0.5995 |
| Energy intake (kJ/day)‡¶ | 9337(177)A | 9767(241)AB | 10134(225)B | 10246(256)AB | 10617(235)B | 0.0001 |
| Fibre intake (g/day)‡¶ | 27.7(1.1)B | 27.5(0.7)B | 27.1(0.9)B | 24.4(0.9)AB | 23.8(0.8)A | <0.0001 |
| Sodium intake (mg/day)‡¶ | 2130(118)A | 2508(78)AB | 2819(82)BC | 3082(129)C | 3239(130)C | <0.0001 |
| Saturated fat intake (g/day)‡¶ | 26.0(0.9)A | 29.8(1.1)AB | 33.6(1.1)BC | 37.2(1.5)C | 38.4(1.4) | <0.0001 |
| Polyunsaturated fat intake (g/day)‡¶ | 12.8(0.6)A | 13.3(0.5)AB | 13.9(0.5)AB | 13.6(0.5)AB | 15.3(0.7)B | 0.0100 |
| Monounsaturated fat intake (g/day)‡¶ | 30.2(1.3)A | 31.7(1.0)AB | 34.4(1.1)AB | 34.7(1.3)AB | 36.4(1.4)B | 0.0003 |
| Trans fat intake (mg/day)‡¶ | 1234(64.0) | 1514(76.2)A | 1697(86.3)AB | 1819(93.6)AB | 1951(114.0)B | <0.0001 |
| Free sugar intake (% energy)‡¶ | 7.2(0.3)A | 8.5(0.5)A | 10.5(0.4)B | 11.6(0.6)B | 14.3(0.5) | <0.0001 |
| Alcohol intake (g/day)‡¶ | 25.0(3.4)C | 20.2(2.3)BC | 13.5(1.5)AB | 13.6(1.7)ABC | 10.1(2.2)A | 0.0006 |
| University graduate (%)‖‖ | 25.3(3.0)A | 23.4(2.6)A | 21.9(3.7)A | 21.6(3.2)A | 22.0(3.6)A | 0.2447 |
| Current smoker daily (%)‖‖ | 8.0(1.8)A | 9.7(2.1)A | 7.6(1.7)A | 12.1(2.1)A | 16.8(2.8)A | 0.0018 |
| Low physical activity level (%)‖‖ | 32.5(3.1)A | 29.1(2.6)A | 39.6(2.8)A | 40.1(3.4)A | 31.7(3.8)A | 0.2624 |
| Born in Australia (%)‖‖ | 52.9(3.7)A | 66.9(3.5)AB | 67.0(4.3)AC | 70.6(3.9)BC | 71.3(4.1)BC | 0.0030 |
| Inner regional living in Australia (%)‖‖ | 17.2(2.2)A | 17.7(2.1)A | 20.7(2.8)A | 18.1(3.0)A | 15.7(2.2)A | 0.4339 |
| Lowest 10% SEIFA ranking (%)‖‖ | 8.0(2.0)A | 8.8(1.8)A | 4.6(1.2)A | 8.8(2.7)A | 10.8(3.3)A | 0.9374 |
| **Approach 2** | | | | | | |
| n | 549 | 487 | 515 | 432 | 465 | - |
| Median proportion of energy from UPF (%) (IQR) | 25.7 | 42.4 | 54.2 | 66.6 | 81.7 | - |
| Median whole-grain intake (g/10MJ/day) (IQR) | 42.0 | 47.7 | 37.0 | 23.4 | 4.0 | - |
| Age‡§ | 48.3(1.1)B | 47.1(1.2)B | 45.1(1.0)B | 39.8(1.1)A | 38.6(1.1)A | <0.0001 |
| Female (%)‖‖ | 48.1(2.8)A | 53.7(3.9)A | 53.3(3.1)A | 43.8(4.1)A | 50.6(2.6)A | 0.2706 |
| Energy intake (kJ/day)‡¶ | 9272(180)A | 9682(251)AB | 10190(251)B | 10382(228)B | 10574(239)B | <0.0001 |
| Fibre intake (g/day)‡¶ | 28.8(1.0)C | 27.4(0.8)BC | 27.5(1.0)BC | 24.5(0.8)AB | 22.2(0.8)A | <0.0001 |
| Sodium intake (mg/day)‡¶ | 2142(115)A | 2444(75)AB | 2731(74)B | 3185(119)C | 3279(133)C | <0.0001 |
| Saturated fat intake (g/day)‡¶ | 25.2(1.0) | 30.1(1.1)A | 33.3(1.3)AB | 37.8(1.5)BC | 38.8(1.3)C | <0.0001 |
| Polyunsaturated fat intake (g/day)‡¶ | 12.6(0.6)A | 13.0(0.5)A | 14.2(0.6)AB | 13.9(0.5)AB | 15.1(0.6)B | 0.0013 |
| Monounsaturated fat intake (g/day)‡¶ | 29.4(1.2)A | 31.3(1.0)A | 33.7(1.1)AB | 36.4(1.2)B | 36.7(1.3)B | <0.0001 |
| Trans fat intake (mg/day)‡¶ | 1216(84.4)A | 1499(63.3)AB | 1704(105.5)BC | 1901(95.7)C | 1897(94.2)C | <0.0001 |
| Free sugar intake (% energy)‡¶ | 7.0(0.3) | 8.8(0.4)A | 10.1(0.4)AB | 11.6(0.5)B | 14.7(0.5) | <0.0001 |
| Alcohol intake (g/day)‡¶ | 22.8(3.2)A | 19.0(2.2)A | 15.3(1.4)A | 13.0(1.8)A | 12.1(2.3)A | 0.0075 |
| University graduate (%)‖‖ | 25.2(3.3)A | 24.9(3.0)A | 20.1(3.6)A | 21.5(3.1)A | 22.4(3.8)A | 0.4634 |
| Current smoker daily (%)‖‖ | 8.8(2.0)A | 8.5(2.2)A | 9.1(1.9)A | 10.7(2.1)A | 17.0(3.0)A | 0.0202 |
| Low physical activity level (%)‖‖ | 29.3(2.8)A | 34.6(3.4)A | 35.8(3.7)A | 38.6(3.7)A | 34.9(3.5)A | 0.6781 |
| Born in Australia (%)‖‖ | 53.6(3.7)A | 67.5(3.5)AB | 68.9(4.3)AB | 66.6(4.2)AB | 72.2(3.5)B | 0.0042 |
| Inner regional living in Australia (%)‖‖ | 16.6(2.3)A | 19.2(2.5)A | 19.0(2.7)A | 19.4(3.4)A | 15.3(2.2)A | 0.4547 |
| Lowest 10% SEIFA ranking (%)‖‖ | 8.2(2.0)A | 7.8(1.6)A | 5.4(1.4)A | 6.8(2.5)A | 12.6(3.4)A | 0.8682 |
| **Approach 3** | | | | | | |
| n | 544 | 493 | 511 | 437 | 463 | - |
| Median proportion of energy from UPF (%) (IQR) | 26.64 | 43.32 | 55.68 | 67.55 | 82.26 | - |
| Median whole-grain intake (g/10MJ/day) (IQR) | 41.52 | 47.29 | 36.92 | 23.36 | 4.47 | - |
| Age‡§ | 48.4(1.1)C | 47.0(1.2)C | 44.2(1.0)BC | 41.1(1.2)AB | 38.3(1.1)A | <0.0001 |
| Female (%)‖‖ | 48.3(2.8)A | 53.4(3.9)A | 51.9(3.5)A | 45.6(4.0)A | 50.3(2.9)A | 0.5814 |
| Energy intake (kJ/day)‡¶ | 9239(184)A | 9588(219)AB | 10310(257)BC | 10296(233)BC | 10668(235)C | <0.0001 |
| Fibre intake (g/day)‡¶ | 28.1(1.0)B | 27.8(0.8)B | 27.8(1.0)B | 23.8(0.8)A | 23.0(0.9)A | <0.0001 |
| Sodium intake (mg/day)‡¶ | 2134(117)A | 2432(76)A | 2823(80)B | 3096(123)BC | 3297(129)C | <0.0001 |
| Saturated fat intake (g/day)‡¶ | 25.6(1.0)A | 29.0(0.9)A | 33.9(1.3)B | 37.6(1.4)BC | 39.0(1.3)C | <0.0001 |
| Polyunsaturated fat intake (g/day)‡¶ | 12.5(0.6)A | 13.2(0.5)AB | 14.2(0.6)AB | 13.6(0.5)AB | 15.4(0.7)B | 0.0014 |
| Monounsaturated fat intake (g/day)‡¶ | 29.5(1.3)A | 31.0(1.0)AB | 34.2(1.1)BC | 35.8(1.3)BC | 37.0(1.3)C | <0.0001 |
| Trans fat intake (mg/day)‡¶ | 1232(84.9)A | 1500(77.6)AB | 1678(93.4)BC | 1923(92.0)C | 1884(93.6)C | <0.0001 |
| Free sugar intake (% energy)‡¶ | 7.2(0.4)A | 8.5(0.4)A | 10.3(0.4)B | 11.6(0.6)B | 14.5(0.6) | <0.0001 |
| Alcohol intake (g/day)‡¶ | 22.9(3.2)A | 18.4(2.2)A | 15.4(1.5)A | 13.5(1.8)A | 12.1(2.5)A | 0.0131 |
| University graduate (%)‖‖ | 24.7(3.2)A | 24.9(3.0)A | 23.0(3.4)A | 20.9(3.0)A | 20.6(3.6)A | 0.2220 |
| Current smoker daily (%)‖‖ | 8.8(2.0)A | 9.7(2.2)A | 7.8(1.7)A | 11.6(2.1)A | 16.2(2.9)A | 0.0602 |
| Low physical activity level (%)‖‖ | 29.5(2.7)A | 31.9(3.1)A | 38.5(3.9)A | 39.5(3.8)A | 33.8(3.73A | 0.1232 |
| Born in Australia (%)‖‖ | 52.9(3.6)A | 67.3(3.7)AB | 70.1(4.0)BC | 67.1(4.0)AC | 71.5(3.9)BC | 0.0022 |
| Inner regional living in Australia (%)‖‖ | 17.1(2.3)A | 18.9(2.3)A | 16.6(2.4)A | 22.2(3.4)A | 14.7(2.2)A | 0.1313 |
| Lowest 10% SEIFA ranking (%)‖‖ | 8.2(1.9)A | 8.6(1.7)A | 4.9(1.3)A | 6.9(2.4)A | 12.4(3.4)A | 0.7264 |

Abbreviations: National Index of Relative Socio-economic Disadvantage 2011 (SEIFA), ultra-processed food (UPF), whole grain (WG).  
\*N (weighted) is based on participants 19 years and over within the NNPAS 2011-12 that have complete information for all characteristics of interest  
† Associations with continuous variables were determined through a test for trend post linear regression. Associations with categorical variables were determined through Pearson’s chi2 analysis. Significance is determined at *P* <0.05.   
‡ Reported as x̅ (SEM)  
§ Linear regression adjusted for sex  
‖ Reported as percentage (SE)  
¶ Linear regression adjusted for age and sex

**Supplementary Material 7.** Association between quintiles of energy intake (%E) from ultra-processed food (UPF) and unadjusted cardiometabolic risk measures for whole-grain modified UPF definitions in Australian adults with 1d of intake.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Proportion of energy intake from UPF (%) a** | | | | | P-value for linear trend‡ | P-value  for sig. difference§ | Adjusted R-squared |
| Q1 | Q2 | Q3 | Q4 | Q5 |
| **Energy adjusted WG intake (g/10MJ/day)||** (n=4461)  **Unadjusted** | | | | | | | | |
| Approach 1 | 47.4(1.2) | 38.0(1.2)A | 37.8(1.2)A | 31.3(1.3)A | 19.8(1.3) | <0.0001 | <0.0001 | 0.0577 |
| Approach 2 | 55.7(1.2) | 44.3(1.2)A | 38.1(1.2)A | 30.0(1.2) | 15.0(1.2) | <0.0001 | <0.0001 | 0.1357 |
| Approach 3 | 55.1(1.3) | 42.6(1.2)A | 39.1(1.1)A | 30.0(1.2) | 15.3(1.2) | <0.0001 | <0.0001 | 0.1277 |
| **Body weight (kg)**(n=6003)  **Unadjusted** | | | | | | | | |
| Approach 1 | 75.0(0.6)A | 76.0(0.6)AB | 77.1(0.7)AB | 76.9(0.7)AB | 77.9(0.7)B | 0.0017 | 0.0393 | 0.0034 |
| Approach 2 | 74.9(0.6)A | 76.5(0.7)AB | 76.8(0.6)AB | 77.1(0.7)AB | 77.6(0.7)B | 0.0038 | 0.0384 | 0.0030 |
| Approach 3 | 75.2(0.6)A | 76.1(0.7)A | 76.8(0.6)A | 77.0(0.6)A | 77.8(0.7)A | 0.0039 | 0.0757 | 0.0028 |
| **BMI (kg/m2)**(n=5970)  **Unadjusted** | | | | | | | | |
| Approach 1 | 26.3(0.2)A | 26.8(0.2)A | 26.8(0.2)A | 26.6(0.2)A | 26.8(0.2)A | 0.0768 | 0.1012 | 0.0018 |
| Approach 2 | 26.3(0.2)A | 26.7(0.2)A | 26.8(0.2)A | 26.6(0.2)A | 26.8(0.2)A | 0.1436 | 0.1527 | 0.0014 |
| Approach 3 | 26.3(0.2)A | 26.8(0.2)A | 26.8(0.2)A | 26.6(0.2)A | 26.8(0.2)A | 0.0996 | 0.1352 | 0.0015 |
| **Waist circumference (cm)** (n=5901)  **Unadjusted** | | | | | | | | |
| Approach 1 | 90.9(0.5)A | 91.8(0.6)A | 92.2(0.6)A | 90.7(0.6)A | 91.1(0.6)A | 0.7253 | 0.3156 | 0.0015 |
| Approach 2 | 91.0(0.5)A | 91.7(0.6)A | 91.8(0.5)A | 91.1(0.5)A | 91.0(0.6)A | 0.6995 | 0.6486 | 0.0007 |
| Approach 3 | 91.2(0.5)A | 91.4(0.6)A | 92.0(0.5)A | 91.0(0.5)A | 91.1(0.6)A | 0.7477 | 0.5968 | 0.0007 |
| **Waist:height ratio** (n=5875)  **Unadjusted** | | | | | | | | |
| Approach 1 | 0.54(0.003)A | 0.55(0.003)A | 0.54(0.003)A | 0.53(0.003)A | 0.54(0.004)A | 0.1010 | 0.0681 | 0.0030 |
| Approach 2 | 0.54(0.003)A | 0.54(0.003)A | 0.54(0.003)A | 0.54(0.003)A | 0.54(0.004)A | 0.1013 | 0.1759 | 0.0018 |
| Approach 3 | 0.54(0.003)A | 0.54(0.003)A | 0.54(0.003)A | 0.54(0.003)A | 0.54(0.004)A | 0.1484 | 0.1901 | 0.0018 |
| **Systolic blood pressure (mmHg)**(n=5787)  **Unadjusted** | | | | | | | | |
| Approach 1 | 123.9(0.7)AB | 125.3(1.0)B | 122.8(0.7)AB | 121.5(0.7)A | 118.2(0.6) | <0.0001 | <0.0001 | 0.0165 |
| Approach 2 | 124.0(0.7)AB | 125.4(1.0)B | 123.1(0.6)AB | 121.2(0.8)A | 118.1(0.6) | <0.0001 | <0.0001 | 0.0178 |
| Approach 3 | 124.0(0.7)AB | 125.5(1.0)B | 122.7(0.7)AB | 121.4(0.8)A | 118.1(0.6) | <0.0001 | <0.0001 | 0.0174 |
| **Diastolic blood pressure (mmHg)** (n=5787)  **Unadjusted** | | | | | | | | |
| Approach 1 | 76.0(0.4)AB | 77.2(0.5)B | 76.4(0.4)AB | 75.8(0.4)AB | 75.2(0.4)A | 0.0313 | 0.0594 | 0.0035 |
| Approach 2 | 75.9(0.4)A | 77.2(0.5)A | 76.1(0.4)A | 75.9(0.4)A | 75.4(0.4)A | 0.0928 | 0.1448 | 0.0028 |
| Approach 3 | 75.9(0.4)A | 77.1(0.5)A | 76.1(0.4)A | 76.2(0.5)A | 75.2(0.4)A | 0.0930 | 0.1162 | 0.0033 |
| **Total cholesterol (mmol/L)** (n=2424)  **Unadjusted** | | | | | | | | |
| Approach 1 | 5.3(0.1)A | 5.1(0.1)A | 5.1(0.1)A | 5.0(0.1)A | 5.0(0.1)A | 0.0243 | 0.1262 | 0.0106 |
| Approach 2 | 5.2(0.1)A | 5.1(0.1)A | 5.1(0.1)A | 5.0(0.1)A | 5.0(0.1)A | 0.0165 | 0.1720 | 0.0096 |
| Approach 3 | 5.2(0.1)A | 5.1(0.1)A | 5.1(0.1)A | 5.0(0.1)A | 5.0(0.1)A | 0.0227 | 0.2319 | 0.0083 |
| **Fasting LDL-cholesterol (mmol/L)**(n=1982)  **Unadjusted** | | | | | | | | |
| Approach 1 | 3.3(0.1)A | 3.2(0.1)A | 3.1(0.1)A | 3.1(0.1)A | 3.2(0.1)A | 0.1075 | 0.3842 | 0.0078 |
| Approach 2 | 3.3(0.1)A | 3.2(0.1)A | 3.1(0.1)A | 3.1(0.1)A | 3.2(0.1)A | 0.0974 | 0.3562 | 0.0080 |
| Approach 3 | 3.3(0.1)A | 3.2(0.1)A | 3.1(0.1)A | 3.1(0.1)A | 3.2(0.1)A | 0.1309 | 0.3677 | 0.0069 |
| **HDL-cholesterol (mmol/L)** (n=2842)  **Unadjusted** | | | | | | | | |
| Approach 1 | 1.4(0.02)AB | 1.4(0.02)B | 1.4(0.02)AB | 1.3(0.02)AB | 1.3(0.02)A | 0.0021 | 0.0187 | 0.0112 |
| Approach 2 | 1.4(0.02)A | 1.4(0.02)A | 1.4(0.02)A | 1.4(0.03)A | 1.3(0.02) | 0.0076 | 0.0043 | 0.0141 |
| Approach 3 | 1.4(0.02)A | 1.4(0.02)A | 1.4(0.02)A | 1.3(0.02)A | 1.3(0.02)A | 0.0332 | 0.1102 | 0.0090 |
| **Fasting triglycerides (mmol/L)** (n=2418)  **Unadjusted** | | | | | | | | |
| Approach 1 | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.7007 | 0.5924 | 0.0028 |
| Approach 2 | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.9527 | 0.2060 | 0.0065 |
| Approach 3 | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.9147 | 0.5941 | 0.0032 |
| **Fasting plasma glucose (mmol/L)** (n=2418)  **Unadjusted** | | | | | | | | |
| Approach 1 | 5.1(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 0.0839 | 0.3873 | 0.0027 |
| Approach 2 | 5.1(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 0.0351 | 0.1370 | 0.0060 |
| Approach 3 | 5.1(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 5.0(1.0)A | 0.0758 | 0.2418 | 0.0037 |
| **HbA1c (%)** (n=2833)  **Unadjusted** | | | | | | | | |
| Approach 1 | 5.5(1.0)B | 5.4(1.0)AB | 5.4(1.0)AB | 5.4(1.0)AB | 5.3(1.0)A | 0.0020 | 0.0213 | 0.0075 |
| Approach 2 | 5.5(1.0)B | 5.4(1.0)AB | 5.4(1.0)AB | 5.4(1.0)AB | 5.3(1.0)A | 0.0042 | 0.0303 | 0.0073 |
| Approach 3 | 5.5(1.0)B | 5.4(1.0)AB | 5.4(1.0)AB | 5.4(1.0)AB | 5.3(1.0)A | 0.0057 | 0.0044 | 0.0096 |
| **Apolipoprotein B (g/L)** (n=2423)  **Unadjusted** | | | | | | | | |
| Approach 1 | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 0.2607 | 0.4490 | 0.0057 |
| Approach 2 | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 0.2988 | 0.5226 | 0.0061 |
| Approach 3 | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 0.2941 | 0.5998 | 0.0046 |
| **C-reactive protein (CRP) (mg/L)** (n=2840)  **Unadjusted** | | | | | | | | |
| Approach 1 | 1.4(1.0)A | 1.3(1.0)A | 1.3(1.0)A | 1.5(1.0)A | 1.6(1.0)A | 0.1441 | 0.1538 | 0.0048 |
| Approach 2 | 1.4(1.0)A | 1.4(1.0)A | 1.3(1.0)A | 1.3(1.0)A | 1.7(1.0)A | 0.1375 | 0.0592 | 0.0109 |
| Approach 3 | 1.4(1.0)A | 1.3(1.0)A | 1.4(1.0)A | 1.4(1.0)A | 1.6(1.0)A | 0.1072 | 0.1319 | 0.0068 |

\* Values are reported as x̅ | SEM  
† Means sharing capital letters within rows are not statistically significant from each other. Significance is determined at P<0.005 (Pairwise comparison with Bonferroni correction for multiple comparisons)  
‡ P-value for linear trend. A significance is determined at *p* <0.05  
§ P-value for significant difference determined through test for equality of means. Significance is determined at p<0.05  
  
*Quintiles sharing capital letters within rows are not statistically significant from each other. Comparison of means were conducted through pairwise comparison. All comparisons applied a Bonferroni correction or multiple comparisons such that a significant difference was observed at P <0.005.*

**Supplementary Material 8.** Association between quintiles of energy intake (%E) from ultra-processed food (UPF) and cardiometabolic risk measures for whole-grain modified UPF definitions in Australian adults with 2d of intake.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Proportion of energy intake from UPF (%) a | | | | | P-value for linear trendb | P-value for sig. differencec | Adjusted R-squared |
| Q1 | Q2 | Q3 | Q4 | Q5 |
| Energy adjusted WG intake (g/10MJ/day)|| (n=2127)  Adjusted | | | | | | | | |
| Approach 1 | 47.67(1.3)C | 37.37(1.3)BC | 37.65(1.25)BC | 32.26(1.27)AB | 22.0(1.43)A | <0.0001 | <0.0001 | 0.1148 |
| Approach 2 | 57.39(1.3)B | 44.32(1.28)AB | 39.39(1.24)A | 29.24(1.22) | 16.17(1.37) | <0.0001 | <0.0001 | 0.1992 |
| Approach 3 | 56.66(1.33)C | 43.45(1.29)BC | 37.53(1.23)AB | 29.73(1.25)A | 17.29(1.36) | <0.0001 | <0.0001 | 0.1811 |
| Unadjusted | | | | | | | |  |
| Approach 1 | 49.68(1.27)B | 37.61(1.31)AB | 38.32(1.24)A | 42.14(1.28)A | 20.66(1.45) | <0.0001 | <0.0001 | 0.0668 |
| Approach 2 | 57.68(1.28)C | 45.12(1.26)BC | 38.38(1.24)AB | 30.05(1.21)A | 15.78(1.4) | <0.0001 | <0.0001 | 0.1557 |
| Approach 3 | 56.91(1.29)C | 44.01(1.29)BC | 37.12(1.24)AB | 30.58(1.24)A | 16.7(1.38) | <0.0001 | <0.0001 | 0.1365 |
| Body weight (kg)|| (n=2785)  Adjusted | | | | | | | | |
| Approach 1 | 72.75(0.66)A | 74.48(0.81)AB | 74.53(0.76)AB | 74.31(0.87)AB | 75.56(0.81)B | 0.0140 | 0.0648 | 0.2578 |
| Approach 2 | 72.73(0.59)A | 74.01(0.85)AB | 74.7(0.85)AB | 74.34(0.76)AB | 75.85(0.89)B | 0.0124 | 0.0666 | 0.2585 |
| Approach 3 | 72.52(0.62)A | 74.21(0.8)AB | 74.48(0.72)AB | 74.61(0.75)AB | 75.81(0.89)B | 0.0054 | 0.0307 | 0.2588 |
| Unadjusted | | | | | | | | |
| Approach 1 | 72.86(0.81)A | 74.59(0.9)A | 74.22(0.9)A | 74.51(1.06)A | 75.45(0.92)A | 0.0681 | 0.3068 | 0.0027 |
| Approach 2 | 73.19(0.69)A | 74.27(0.92)A | 74.27(1.02)A | 74.04(0.92)A | 75.86(1.05)A | 0.0862 | 0.3493 | 0.0029 |
| Approach 3 | 73.08(0.71)A | 74.25(0.91)A | 73.83(0.91)A | 74.66(0.94)A | 75.81(1.02)A | 0.0455 | 0.2560 | 0.0032 |
| BMI (kg/m2)|| (n=2775)  Adjusted | | | | | | | | |
| Approach 1 | 25.51(0.23)A | 25.79(0.25)A | 25.92(0.24)A | 25.67(0.25)A | 26.33(0.26)A | 0.0261 | 0.1810 | 0.1240 |
| Approach 2 | 25.5(0.2)A | 25.66(0.25)A | 25.77(0.24)A | 25.91(0.25)A | 26.38(0.26)A | 0.0046 | 0.0898 | 0.1234 |
| Approach 3 | 25.38(0.22)A | 25.71(0.24)AB | 25.86(0.22)AB | 25.91(0.25)AB | 26.35(0.26)B | 0.0026 | 0.0589 | 0.1247 |
| Unadjusted | | | | | | | | |
| Approach 1 | 25.87(0.23)A | 25.95(0.27)A | 26.05(0.28)A | 25.5(0.3)A | 25.85(0.29)A | 0.5146 | 0.6985 | 0.0015 |
| Approach 2 | 25.85(0.2)A | 26.01(0.26)A | 25.7(0.29)A | 25.67(0.31)A | 25.89(0.3)A | 0.8517 | 0.9602 | 0.0005 |
| Approach 3 | 25.76(0.21)A | 26.01(0.26)A | 25.76(0.27)A | 25.81(0.31)A | 25.87(0.29)A | 0.9981 | 0.9604 | 0.0004 |
| Waist circumference (cm)|| (n=2738)  Adjusted | | | | | | | | |
| Approach 1 | 88.43(0.62)A | 89.61(0.65)A | 89.84(0.64)A | 89.21(0.71)A | 90.89(0.67)A | 0.0211 | 0.0920 | 0.2927 |
| Approach 2 | 88.35(0.62)A | 89.27(0.74)AB | 89.36(0.58)AB | 89.81(0.58)AB | 91.18(0.7)B | 0.0027 | 0.0487 | 0.2936 |
| Approach 3 | 88.2(0.64)A | 89.36(0.66)AB | 89.15(0.52)AB | 89.96(0.62)AB | 91.31(0.7)B | 0.0009 | 0.0167 | 0.2945 |
| Unadjusted | | | | | | | | |
| Approach 1 | 89.77(0.69)A | 90.16(0.76)A | 90.23(0.8)A | 88.7(0.92)A | 89.11(0.81)A | 0.2530 | 0.6074 | 0.0019 |
| Approach 2 | 89.81(0.67)A | 90.35(0.86)A | 89.05(0.84)A | 89.29(0.88)A | 89.46(0.91)A | 0.5072 | 0.8800 | 0.0011 |
| Approach 3 | 89.69(0.69)A | 90.33(0.8)A | 88.74(0.79)A | 89.7(0.92)A | 89.51(0.85)A | 0.7010 | 0.7819 | 0.0014 |
| Waist:height ratio|| (n=2729)  Adjusted | | | | | | | | |
| Approach 1 | 0.52(0.004)A | 0.53(0.004)A | 0.53(0.004)A | 0.53(0.004)A | 0.54(0.004)A | 0.0416 | 0.1567 | 0.2526 |
| Approach 2 | 0.52(0.004)A | 0.53(0.004)A | 0.53(0.003)A | 0.53(0.004)A | 0.54(0.004)A | 0.0017 | 0.0320 | 0.2531 |
| Approach 3 | 0.52(0.004)A | 0.53(0.004)AB | 0.53(0.003)AB | 0.53(0.004)AB | 0.54(0.004)B | 0.0011 | 0.0232 | 0.2537 |
| Unadjusted | | | | | | | | |
| Approach 1 | 0.54(0.004)A | 0.53(0.005)A | 0.54(0.005)A | 0.52(0.005)A | 0.52(0.005)A | 0.0035 | 0.0322 | 0.0075 |
| Approach 2 | 0.53(0.004)A | 0.54(0.005)A | 0.53(0.005)A | 0.53(0.005)A | 0.52(0.005)A | 0.0435 | 0.2344 | 0.0037 |
| Approach 3 | 0.53(0.004)A | 0.54(0.005)A | 0.53(0.005)A | 0.53(0.006)A | 0.52(0.005)A | 0.0591 | 0.2763 | 0.0030 |
| Systolic blood pressure (mmHg)¶ (n=2700)  Adjusted | | | | | | | | |
| Approach 1 | 120.0(0.89)A | 122.6(0.98)A | 123.1(1.1)A | 121.3(0.88)A | 121.5(0.86)A | 0.5590 | 0.1769 | 0.3007 |
| Approach 2 | 120.2(0.84)A | 121.9(0.94)A | 123.8(1.3)A | 120.9(0.96)A | 121.8(0.87)A | 0.4387 | 0.2288 | 0.3015 |
| Approach 3 | 120.4(0.89)A | 122.2(0.95)A | 123.7(1.2)A | 120.5(0.86)A | 121.7(0.88)A | 0.7390 | 0.1747 | 0.3015 |
| Unadjusted | | | | | | | | |
| Approach 1 | 123.0(1.03)BC | 124.0(1.23)BC | 124.3(1.17)C | 119.7(1.05)AB | 117.6(0.86)A | <0.0001 | 0.0001 | 0.0198 |
| Approach 2 | 123.0(1.03)B | 124.0(1.18)B | 123.8(1.37)B | 120.1(1.17)AB | 117.7(0.89)A | <0.0001 | 0.0001 | 0.0170 |
| Approach 3 | 123.3(1.02)B | 124.1(1.21)B | 123.8(1.35)B | 119.7(1.06)AB | 117.7(0.89)A | <0.0001 | 0.0001 | 0.0183 |
| Diastolic blood pressure (mmHg)¶ (n=2700)  Adjusted | | | | | | | | |
| Approach 1 | 75.32(0.63)A | 75.9(0.54)A | 75.93(0.65)A | 75.56(0.7)A | 75.8(0.53)A | 0.4539 | 0.6565 | 0.1449 |
| Approach 2 | 75.13(0.58)A | 75.94(0.59)A | 75.43(0.6)A | 75.89(0.77)A | 75.13(0.5)A | 0.9759 | 0.8365 | 0.1445 |
| Approach 3 | 75.24(0.58)A | 75.96(0.61)A | 75.63(0.65)A | 75.55(0.71)A | 75.12(0.49)A | 0.7031 | 0.8807 | 0.1442 |
| Unadjusted | | | | | | | | |
| Approach 1 | 75.82(0.58)A | 76.18(0.6)A | 76.37(0.68)A | 75.1(0.68)A | 74.03(0.62)A | 0.0112 | 0.0614 | 0.0063 |
| Approach 2 | 75.6(0.59)A | 76.4(0.68)A | 75.3(0.63)A | 75.89(0.84)A | 74.3(0.53)A | 0.0773 | 0.1077 | 0.0042 |
| Approach 3 | 75.68(0.58)A | 76.38(0.7)A | 75.64(0.67)A | 75.43(0.79)A | 74.36(0.51)A | 0.0467 | 0.1355 | 0.0037 |
| Total cholesterol (mmol/L)\*\* (n=1332)  Adjusted | | | | | | | | |
| Approach 1 | 4.09(0.43)A | 4.25(0.45)A | 4.1(0.44)A | 4.13(0.42)A | 4.09(0.43)A | 0.6760 | 0.7803 | 0.1861 |
| Approach 2 | 5.04(0.1)A | 5.11(0.09)A | 5.05(0.08)A | 5.02(0.06)A | 5.05(0.08)A | 0.8009 | 0.9431 | 0.1838 |
| Approach 3 | 5.05(0.09)A | 5.11(0.09)A | 5.0(0.08)A | 5.05(0.07)A | 5.06(0.08)A | 0.9048 | 0.9447 | 0.1840 |
| Unadjusted | | | | | | | | |
| Approach 1 | 5.15(0.1)A | 5.25(0.1)A | 4.96(0.1)A | 5.02(0.09)A | 4.88(0.09)A | 0.0078 | 0.0457 | 0.0195 |
| Approach 2 | 5.23(0.08)A | 5.15(0.11)A | 4.98(0.09)A | 4.99(0.07)A | 4.91(0.09)A | 0.0089 | 0.1301 | 0.0150 |
| Approach 3 | 5.22(0.08)A | 5.15(0.1)A | 4.93(0.09)A | 5.03(0.08)A | 4.93(0.09)A | 0.0161 | 0.1390 | 0.0147 |
| Fasting LDL-cholesterol (mmol/L)\*\* (n=1116)  Adjusted | | | | | | | | |
| Approach 1 | 3.12(0.1)A | 3.21(0.09)A | 3.09(0.07)A | 3.21(0.06)A | 3.06(0.08)A | 0.6759 | 0.4578 | 0.2324 |
| Approach 2 | 3.15(0.1)A | 3.21(0.07)A | 3.1(0.07)A | 3.17(0.05)A | 3.08(0.07)A | 0.5206 | 0.7081 | 0.2303 |
| Approach 3 | 3.16(0.09)A | 3.21(0.07)A | 3.09(0.07)A | 3.18(0.06)A | 3.07(0.07)A | 0.4715 | 0.6849 | 0.2307 |
| Unadjusted | | | | | | | | |
| Approach 1 | 3.21(0.1)AB | 3.31(0.09)A | 3.01(0.09)AB | 3.18(0.08)AB | 2.99(0.09)A | 0.0294 | 0.0567 | 0.0226 |
| Approach 2 | 3.3(0.09)A | 3.26(0.09)A | 3.0(0.09)A | 3.13(0.06)A | 3.0(0.08)A | 0.0096 | 0.1075 | 0.0234 |
| Approach 3 | 3.3(0.09)A | 3.25(0.08)A | 2.99(0.09)A | 3.16(0.07)A | 3.0(0.08)A | 0.0120 | 0.0903 | 0.0228 |
| HDL-cholesterol (mmol/L)\*\* (n=1550)  Adjusted | | | | | | | | |
| Approach 1 | 1.36(0.03)A | 1.4(0.03)A | 1.38(0.03)A | 1.36(0.03)A | 1.39(0.03)A | 0.9090 | 0.7788 | 0.2845 |
| Approach 2 | 1.37(0.03)A | 1.39(0.03)A | 1.36(0.03)A | 1.37(0.02)A | 1.38(0.04)A | 0.9262 | 0.9744 | 0.2832 |
| Approach 3 | 1.37(0.03)A | 1.38(0.03)A | 1.37(0.03)A | 1.38(0.03)A | 1.38(0.04)A | 0.8053 | 0.9968 | 0.2827 |
| Unadjusted | | | | | | | | |
| Approach 1 | 1.38(0.03)A | 1.43(0.04)A | 1.38(0.04)A | 1.35(0.03)A | 1.34(0.03)A | 0.1398 | 0.4600 | 0.0066 |
| Approach 2 | 1.39(0.02)A | 1.42(0.05)A | 1.38(0.04)A | 1.35(0.03)A | 1.35(0.04)A | 0.1231 | 0.5597 | 0.0052 |
| Approach 3 | 1.39(0.03)A | 1.4(0.05)A | 1.39(0.04)A | 1.36(0.03)A | 1.35(0.04)A | 0.2427 | 0.8203 | 0.0029 |
| Fasting triglycerides (mmol/L) †† (n=1345)  Adjusted | | | | | | | | |
| Approach 1 | 1.05(1.0)A | 1.03(1.0)A | 1.06(1.0)A | 1.08(1.0)A | 1.12(1.01)A | 0.2114 | 0.7516 | 0.2274 |
| Approach 2 | 1.03(1.0)A | 1.02(1.0)A | 1.09(1.0)A | 1.08(1.0)A | 1.12(1.1)A | 0.0924 | 0.3220 | 0.2292 |
| Approach 3 | 1.04(1.0)A | 1.03(1.0)A | 1.08(1.0)A | 1.08(1.0)A | 1.11(1.0)A | 0.1532 | 0.5788 | 0.2272 |
| Unadjusted | | | | | | | | |
| Approach 1 | 1.12(1.0)A | 1.09(1.0)A | 1.09(1.0)A | 1.11(1.0)A | 1.1(1.0)A | 0.8197 | 0.9934 | 0.0004 |
| Approach 2 | 1.12(1.0)A | 1.06(1.0)A | 1.11(1.01)A | 1.12(1.01)A | 1.11(1.0)A | 0.7622 | 0.7502 | 0.0022 |
| Approach 3 | 1.13(1.0)A | 1.07(1.0)A | 1.1(1.0)A | 1.11(1.0)A | 1.11(1.0)A | 0.9615 | 0.9357 | 0.0014 |
| Fasting blood glucose (mmol/L)‡‡ (n=1345)  Adjusted | | | | | | | | |
| Approach 1 | 5.01(1.02)A | 5.03(1.02)A | 4.93(1.01)A | 5.0(1.02)A | 5.0(1.02)A | 0.8170 | 0.5074 | 0.2499 |
| Approach 2 | 5.01(1.02)A | 4.99(1.02)A | 4.98(1.02)A | 4.97(1.01)A | 5.01(1.02)A | 0.8904 | 0.9461 | 0.2480 |
| Approach 3 | 5.0(1.02)A | 4.96(1.02)A | 5.0(1.02)A | 4.99(1.01)A | 5.01(1.02)A | 0.7952 | 0.9756 | 0.2480 |
| Unadjusted | | | | | | | | |
| Approach 1 | 5.11(1.02)A | 5.11(1.02)A | 4.99(1.02)A | 5.04(1.02)A | 4.94(1.01)A | 0.0154 | 0.0598 | 0.0098 |
| Approach 2 | 5.13(1.02)A | 5.07(1.02)A | 5.0(1.03)A | 5.01(1.01)A | 4.96(1.01)A | 0.0342 | 0.3338 | 0.0074 |
| Approach 3 | 5.13(1.02)A | 5.04(1.02)A | 5.02(1.07)A | 5.03(1.02)A | 4.97(1.01)A | 0.0733 | 0.5002 | 0.0058 |
| HbA1c (%)‡‡ (n=1542)  Adjusted | | | | | | | | |
| Approach 1 | 5.42(1.01)A | 5.44(1.01)A | 5.34(1.01)A | 5.39(1.01)A | 5.36(1.01)A | 0.2578 | 0.4486 | 0.2439 |
| Approach 2 | 5.42(1.01)A | 5.38(1.01)A | 5.42(1.01)A | 5.34(1.01)A | 5.39(1.01)A | 0.4324 | 0.3416 | 0.2429 |
| Approach 3 | 5.4(1.01)A | 5.4(1.01)A | 5.41(1.01)A | 5.39(1.01)A | 5.36(1.01)A | 0.4526 | 0.8950 | 0.2405 |
| Unadjusted | | | | | | | | |
| Approach 1 | 5.52(1.01)B | 5.51(1.01)B | 5.4(1.01)AB | 5.42(1.01)AB | 5.32(1.01)A | 0.0003 | 0.0054 | 0.0206 |
| Approach 2 | 5.53(1.01)B | 5.46(1.01)AB | 5.44(1.01)AB | 5.39(1.01)AB | 5.35(1.01)A | 0.0012 | 0.0292 | 0.0150 |
| Approach 3 | 5.51(1.01)B | 5.48(1.01)B | 5.44(1.01)AB | 5.42(1.01)AB | 5.32(1.01)A | 0.0006 | 0.0041 | 0.0160 |
| Apolipoprotein B (g/L)\*\* (n=1332)  Adjusted | | | | | | | | |
| Approach 1 | 1.0(0.03)A | 1.0(0.02)A | 1.0(0.02)A | 0.98(0.02)A | 0.95(0.02)A | 0.1418 | 0.5354 | 0.2184 |
| Approach 2 | 1.0(0.03)A | 1.0(0.02)A | 0.99(0.02)A | 0.98(0.02)A | 0.97(0.02)A | 0.2665 | 0.7906 | 0.2165 |
| Approach 3 | 1.0(0.03)A | 1.01(0.02)A | 0.98(0.02)A | 0.98(0.02)A | 0.96(0.02)A | 0.1886 | 0.6066 | 0.2173 |
| Unadjusted | | | | | | | | |
| Approach 1 | 1.02(0.02)A | 1.02(0.03)A | 0.98(0.03)A | 0.99(0.03)A | 0.93(0.03)A | 0.0073 | 0.0961 | 0.0134 |
| Approach 2 | 1.03(0.02)A | 1.0(0.03)A | 0.97(0.03)A | 0.98(0.02)A | 0.95(0.02)A | 0.0206 | 0.2323 | 0.0116 |
| Approach 3 | 1.04(0.02)A | 1.01(0.02)A | 0.96(0.03)A | 0.99(0.02)A | 0.95(0.02)A | 0.0155 | 0.1559 | 0.0142 |
| C-reactive protein (CRP) (mg/L)\*\* (n=1550)  Adjusted | | | | | | | | |
| Approach 1 | 1.33(1.02)A | 1.18(1.01)A | 1.27(1.02)A | 1.35(1.02)A | 1.56(1.05)A | 0.0942 | 0.2775 | 0.2522 |
| Approach 2 | 1.31(1.02)A | 1.2(1.02)A | 1.3(1.02)A | 1.29(1.02)A | 1.57(1.05)A | 0.1266 | 0.3711 | 0.2518 |
| Approach 3 | 1.34(1.02)A | 1.19(1.02)A | 1.27(1.02)A | 1.33(1.02)A | 1.55(1.05)A | 0.1155 | 0.3037 | 0.2516 |
| Unadjusted | | | | | | | | |
| Approach 1 | 1.46(1.03)A | 1.26(1.02)A | 1.3(1.02)A | 1.44(1.03)A | 1.6(1.05)A | 0.2999 | 0.3710 | 0.0069 |
| Approach 2 | 1.5(1.03)A | 1.24(1.02)A | 1.24(1.02)A | 1.41(1.03)A | 1.69(1.05)A | 0.2342 | 0.1056 | 0.0123 |
| Approach 3 | 1.52(1.03)A | 1.22(1.02)A | 1.25(1.02)A | 1.43(1.03)A | 1.67(1.05)A | 0.2429 | 0.0913 | 0.0123 |

\* Values are reported as x̅ | SEM  
† Means sharing capital letters within rows are not statistically significant from each other. Significance is determined at P<0.005 (Pairwise comparison with Bonferroni correction for multiple comparisons)  
‡ P-value for linear trend. A significance is determined at *p* <0.05  
§ P-value for significant difference determined through test for equality of means. Significance is determined at p<0.05  
‖ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, and area remoteness  
¶ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, Na intake, and BMI  
\*\* Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, saturated fat intake, monounsaturated fat, polyunsaturated fat intake, trans saturated fat intake, alcohol intake, and BMI  
†† Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, saturated fat intake, monounsaturated fat, polyunsaturated fat intake, trans saturated fat intake, free sugar intake, alcohol intake, and BMI  
‡‡ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, free sugar intake, and BMI

*Quintiles sharing capital letters within rows are not statistically significant from each other. Comparison of means were conducted through pairwise comparison. All comparisons applied a Bonferroni correction or multiple comparisons such that a significant difference was observed at P <0.005.*

**Supplementary Material 9.** Association between quintiles of energy intake (%E) from ultra-processed food (UPF) and cardiometabolic risk measures for whole-grain modified UPF definitions in Australian adults with 1 or 2d of intake.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Proportion of energy intake from UPF (%) a** | | | | | P-value for linear trendb | P-value for sig. differencec | Adjusted R-squared |
| Q1 | Q2 | Q3 | Q4 | Q5 |
| **Energy adjusted WG intake (g/10MJ/day)||** (n=3952)  **Adjusted** | | | | | | | | |
| Approach 1 | 41.08(1.26)B | 33.25(1.24)AB | 34.03(1.21)AB | 29.28(1.2)A | 20.5(1.26) | <0.0001 | <0.0001 | 0.0830 |
| Approach 2 | 49.27(1.26)B | 39.61(1.02)AB | 34.24(1.21)A | 26.57(1.16) | 15.72(1.23) | <0.0001 | <0.0001 | 0.1420 |
| Approach 3 | 48.45(1.26)C | 38.3(1.25)BC | 34.36(1.19)AB | 27.68(1.17)A | 15.81(1.24) | <0.0001 | <0.0001 | 0.1365 |
| **Unadjusted** | | | | | | | |  |
| Approach 1 | 42.1(1.25)B | 34.23(1.25)AB | 34.61(1.19)AB | 29.17(1.21)A | 19.18(1.26) | <0.0001 | <0.0001 | 0.0465 |
| Approach 2 | 49.98(1.25)B | 40.21(1.22)AB | 34.31(1.2)A | 26.83(1.15) | 15.08(1.24) | <0.0001 | <0.0001 | 0.1125 |
| Approach 3 | 48.91(1.26)C | 39.02(1.25)BC | 34.48(1.17)AB | 27.97(1.16)A | 15.16(1.24) | <0.0001 | <0.0001 | 0.1126 |
| **Body weight (kg)||** (n=4867)  **Adjusted** | | | | | | | | |
| Approach 1 | 74.03(0.49)A | 75.18(0.64)AB | 75.2(0.62)AB | 75.31(0.72)AB | 76.88(0.57)B | 0.0006 | 0.0027 | 0.2371 |
| Approach 2 | 73.92(0.57)A | 74.49(0.64)AB | 75.53(0.65)AB | 76.55(0.69)B | 76.13(0.63)AB | 0.0010 | 0.0179 | 0.2376 |
| Approach 3 | 74.03(0.55)A | 74.47(0.63)A | 75.15(0.62)A | 76.51(0.72)A | 76.45(0.64)A | 0.0007 | 0.0203 | 0.2377 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 74.05(0.56)A | 75.22(0.67)AB | 75.23(0.75)AB | 75.23(0.75)AB | 76.87(0.71)B | 0.0091 | 0.0517 | 0.0030 |
| Approach 2 | 74.02(0.64)A | 74.52(0.69)A | 75.41(0.77)A | 76.39(0.78)A | 76.26(0.73)A | 0.0039 | 0.0700 | 0.0032 |
| Approach 3 | 74.27(0.62)A | 74.39(0.66)A | 74.9(0.74)A | 76.52(0.76)A | 76.53(0.75)A | 0.0043 | 0.0678 | 0.0037 |
| **BMI (kg/m2)||** (n=4842)  **Adjusted** | | | | | | | | |
| Approach 1 | 25.91(0.14)A | 26.13(0.2)AB | 26.21(0.2)AB | 26.23(0.22)AB | 26.75(0.18)B | 0.0014 | 0.0230 | 0.0973 |
| Approach 2 | 25.84(0.15)A | 25.96(0.19)AB | 26.15(0.2)AB | 26.71(0.23)B | 26.57(0.19)AB | 0.0002 | 0.0044 | 0.0988 |
| Approach 3 | 25.88(0.16)AB | 25.91(0.17)AC | 26.12(0.2)ABC | 26.68(0.23)CD | 26.65(0.19)BD | 0.0003 | 0.0061 | 0.0990 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 26.15(0.15)A | 26.27(0.21)A | 26.35(0.23)A | 26.1(0.23)A | 26.36(0.2)A | 0.6752 | 0.8368 | 0.0005 |
| Approach 2 | 26.08(0.15)A | 26.18(0.19)A | 26.18(0.23)A | 26.61(0.24)A | 26.19(0.22)A | 0.2825 | 0.4283 | 0.0014 |
| Approach 3 | 26.1(0.16)A | 26.14(0.18)A | 26.17(0.22)A | 26.56(0.25)A | 26.27(0.22)A | 0.2321 | 0.6099 | 0.0011 |
| **Waist circumference (cm)||** (n=4781)  **Adjusted** | | | | | | | | |
| Approach 1 | 89.83(0.38)A | 89.93(0.5)AB | 90.31(0.5)AB | 90.4(0.57)AB | 91.7(0.52)B | 0.0008 | 0.0094 | 0.2704 |
| Approach 2 | 89.23(0.43)A | 89.33(0.51)A | 90.14(0.46)AB | 91.58(0.56)B | 91.43(0.48)B | <0.0001 | 0.0009 | 0.2724 |
| Approach 3 | 89.29(0.42)A | 89.36(0.47)A | 89.87(0.45)AB | 91.53(0.59)B | 91.67(0.5)B | <0.0001 | 0.0007 | 0.2728 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 90.33(0.46)A | 90.64(0.56)A | 90.83(0.6)A | 89.79(0.65)A | 90.14(0.64)A | 0.4980 | 0.7961 | 0.0007 |
| Approach 2 | 90.32(0.45)A | 90.14(0.61)A | 90.33(0.6)A | 91.06(0.64)A | 89.87(0.63)A | 0.9882 | 0.7415 | 0.0008 |
| Approach 3 | 90.39(0.49)A | 90.14(0.54)A | 90.03(0.59)A | 91.0(0.64)A | 90.15(0.64)A | 0.8308 | 0.7589 | 0.0006 |
| **Waist:height ratio||** (n=4759)  **Adjusted** | | | | | | | | |
| Approach 1 | 0.53(0.002)A | 0.53(0.003)AB | 0.53(0.003)AB | 0.53(0.003)AB | 0.54(0.003)B | 0.0024 | 0.0425 | 0.2299 |
| Approach 2 | 0.53(0.002)A | 0.53(0.003)A | 0.53(0.003)AB | 0.54(0.003)B | 0.54(0.003)B | <0.0001 | 0.0003 | 0.2325 |
| Approach 3 | 0.53(0.002)A | 0.53(0.003)A | 0.53(0.003)AB | 0.54(0.004)B | 0.54(0.003)B | <0.0001 | 0.0003 | 0.2328 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 0.54(0.002)A | 0.54(0.003)A | 0.54(0.004)A | 0.53(0.004)A | 0.53(0.004)A | 0.0106 | 0.1209 | 0.0030 |
| Approach 2 | 0.54(0.002)A | 0.54(0.003)A | 0.53(0.003)A | 0.54(0.004)A | 0.53(0.004)A | 0.1032 | 0.2063 | 0.0021 |
| Approach 3 | 0.54(0.003)A | 0.54(0.003)A | 0.53(0.004)A | 0.54(0.004)A | 0.53(0.004)A | 0.1896 | 0.5052 | 0.0013 |
| **Systolic blood pressure (mmHg)**¶ (n=4699)  **Adjusted** | | | | | | | | |
| Approach 1 | 121.6(0.68)A | 123.0(0.75)A | 121.9(0.8)A | 122.1(0.67)A | 121.9(0.71)A | 0.8923 | 0.7314 | 0.2881 |
| Approach 2 | 122.1(0.74)A | 122.1(0.69)A | 122.8(0.8)A | 121.7(0.84)A | 121.8(0.71)A | 0.6626 | 0.8721 | 0.2878 |
| Approach 3 | 122.1(0.71)A | 122.3(0.69)A | 123.0(0.84)A | 121.3(0.74)A | 121.8(0.69)A | 0.4698 | 0.7003 | 0.2882 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 124.1(0.8)C | 124.6(0.92)C | 122.9(0.82)BC | 120.4(0.72)AB | 118.4(0.72)A | <0.0001 | <0.0001 | 0.0153 |
| Approach 2 | 124.6(0.88)C | 123.9(0.78)BC | 123.3(0.86)BC | 120.7(0.88)AB | 188.0(0.7)A | <0.0001 | <0.0001 | 0.0163 |
| Approach 3 | 124.6(0.83)C | 124.0(0.82)BC | 123.3(0.89)BC | 120.4(0.85)AB | 118.2(0.7)A | <0.0001 | <0.0001 | 0.0166 |
| **Diastolic blood pressure (mmHg)**¶ (n=4699)  **Adjusted** | | | | | | | | |
| Approach 1 | 75.78(0.46)A | 76.54(0.47)A | 76.02(0.41)A | 75.48(0.39)A | 75.75(0.43)A | 0.4106 | 0.4403 | 0.1356 |
| Approach 2 | 75.8(0.49)A | 76.33(0.43)A | 75.78(0.42)A | 75.94(0.51)A | 75.72(0.4)A | 0.6992 | 0.8257 | 0.1350 |
| Approach 3 | 75.99(0.47)A | 76.3(0.46)A | 76.0(0.46)A | 74.48(0.42)A | 75.8(0.38)A | 0.3606 | 0.7291 | 0.1352 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 76.19(0.43)A | 76.8(0.51)A | 76.31(0.44)A | 75.08(0.39)A | 75.2(0.46)A | 0.0059 | 0.0234 | 0.0038 |
| Approach 2 | 76.2(0.5)A | 76.59(0.47)A | 75.78(0.45)A | 75.99(0.55)A | 75.0(0.41)A | 0.0315 | 0.1040 | 0.0023 |
| Approach 3 | 76.38(0.46)A | 76.48(0.5)A | 76.04(0.47)A | 75.47(0.49)A | 75.2(0.4)A | 0.0112 | 0.1253 | 0.0021 |
| **Total cholesterol (mmol/L)\*\*** (n=1933)  **Adjusted** | | | | | | | | |
| Approach 1 | 5.1(0.08)A | 5.19(0.07)A | 5.08(0.07)A | 5.02(0.07)A | 5.04(0.07)A | 0.2238 | 0.4401 | 0.1496 |
| Approach 2 | 5.16(0.07)A | 5.13(0.08)A | 5.09(0.07)A | 5.06(0.06)A | 5.01(0.07)A | 0.1337 | 0.6984 | 0.1483 |
| Approach 3 | 5.13(0.07)A | 5.15(0.06)A | 5.07(0.06)A | 5.04(0.06)A | 5.05(0.06)A | 0.2245 | 0.5945 | 0.1478 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 5.19(0.08)A | 5.23(0.07)A | 5.05(0.07)A | 5.01(0.07)A | 4.95(0.07)A | 0.0032 | 0.0276 | 0.0133 |
| Approach 2 | 5.27(0.07)B | 5.16(0.09)AB | 5.05(0.07)AB | 5.07(0.06)AB | 4.9(0.08)A | 0.0009 | 0.0222 | 0.0166 |
| Approach 3 | 5.24(0.07)B | 5.17(0.08)AB | 5.03(0.06)AB | 5.04(0.07)AB | 4.96(0.07)A | 0.0024 | 0.0376 | 0.0119 |
| **Fasting LDL-cholesterol (mmol/L)\*\*** (n=1982)  **Adjusted** | | | | | | | | |
| Approach 1 | 3.2(0.08)A | 3.27(0.06)A | 3.14(0.06)A | 3.2(0.07)A | 3.13(0.06)A | 0.3852 | 0.5179 | 0.1938 |
| Approach 2 | 3.24(0.07)A | 3.24(0.06)A | 3.16(0.06)A | 3.21(0.06)A | 3.08(0.06)A | 0.1241 | 0.4706 | 0.1955 |
| Approach 3 | 3.25(0.07)A | 3.24(0.06)A | 3.15(0.05)A | 3.18(0.06)A | 3.11(0.06)A | 0.1348 | 0.5387 | 0.1940 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 3.23(0.08)A | 3.32(0.06)A | 3.11(0.07)A | 3.18(0.07)A | 3.08(0.07)A | 0.0507 | 0.0852 | 0.0114 |
| Approach 2 | 3.31(0.07)A | 3.28(0.08)A | 3.1(0.07)A | 3.21(0.07)A | 3.03(0.07)A | 0.0080 | 0.0887 | 0.0165 |
| Approach 3 | 3.32(0.07)A | 3.26(0.07)A | 3.08(0.06)A | 3.18(0.07)A | 3.08(0.06)A | 0.0129 | 0.1052 | 0.0135 |
| **HDL-cholesterol (mmol/L)\*\*** (n=2239)  **Adjusted** | | | | | | | | |
| Approach 1 | 1.36(0.02)A | 1.38(0.02)A | 1.36(0.02)A | 1.34(0.03)A | 1.37(0.03)A | 0.7774 | 0.7954 | 0.2776 |
| Approach 2 | 1.38(0.02)A | 1.37(0.03)A | 1.35(0.02)A | 1.35(0.03)A | 1.36(0.03)A | 0.5021 | 0.8309 | 0.2775 |
| Approach 3 | 1.38(0.02)A | 1.37(0.03)A | 1.35(0.02)A | 1.36(0.03)A | 1.36(0.03)A | 0.6147 | 0.9109 | 0.2769 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 1.38(0.02)A | 1.4(0.03)A | 1.38(0.03)A | 1.32(0.03)A | 1.33(0.03)A | 0.0220 | 0.1965 | 0.0078 |
| Approach 2 | 1.39(0.02)A | 1.4(0.03)A | 1.37(0.03)A | 1.32(0.03)A | 1.32(0.03)A | 0.0111 | 0.1320 | 0.0086 |
| Approach 3 | 1.39(0.02)A | 1.4(0.03)A | 1.37(0.03)A | 1.33(0.03)A | 1.32(0.03)A | 0.0124 | 0.1682 | 0.0081 |
| **Fasting triglycerides (mmol/L)** †† (n=1890)  **Adjusted** | | | | | | | | |
| Approach 1 | 1.07(1.0)A | 1.1(1.0)A | 1.09(1.0)A | 1.08(1.0)A | 1.11(1.0)A | 0.6128 | 0.9583 | 0.2359 |
| Approach 2 | 1.09(1.0)A | 1.03(1.0)A | 1.13(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.3796 | 0.3652 | 0.2393 |
| Approach 3 | 1.06(1.0)A | 1.05(1.0)A | 1.13(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.3541 | 0.5669 | 0.2378 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 1.1(1.0)A | 1.11(1.0)A | 1.08(1.0)A | 1.07(1.0)A | 1.08(1.0)A | 0.5571 | 0.9613 | 0.0006 |
| Approach 2 | 1.14(1.0)A | 1.02(1.0)A | 1.11(1.0)A | 1.11(1.0)A | 1.08(1.0)A | 0.8926 | 0.2828 | 0.0061 |
| Approach 3 | 1.11(1.0)A | 1.05(1.0)A | 1.11(1.0)A | 1.1(1.0)A | 1.08(1.0)A | 0.9800 | 0.7147 | 0.0020 |
| **Fasting blood glucose (mmol/L)**‡‡(n=1890)  **Adjusted** | | | | | | | | |
| Approach 1 | 5.0(1.01)A | 4.98(1.01)A | 4.93(1.01)A | 5.02(1.02)A | 4.99(1.01)A | 0.8564 | 0.5115 | 0.2392 |
| Approach 2 | 4.99(1.01)A | 5.0(1.01)A | 4.96(1.01)A | 4.97(1.01)A | 5.0(1.01)A | 0.9551 | 0.9159 | 0.2377 |
| Approach 3 | 5.0(1.01)A | 4.97(1.01)A | 4.95(1.01)A | 5.01(1.01)A | 4.99(1.01)A | 0.9705 | 0.7535 | 0.2382 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 5.06(1.01)A | 5.0(1.02)A | 4.92(1.01)A | 5.0(1.02)A | 4.95(1.01)A | 0.1308 | 0.1731 | 0.0057 |
| Approach 2 | 5.08(1.02)A | 5.01(1.01)A | 4.92(1.02)A | 4.96(1.01)A | 4.97(1.02)A | 0.0640 | 0.1106 | 0.0069 |
| Approach 3 | 5.09(1.02)B | 4.99(1.01)AB | 4.89(1.01)A | 5.01(1.01)AB | 4.96(1.01)AB | 0.1019 | 0.0514 | 0.0098 |
| **HbA1c (%)**‡‡ (n=2230)  **Adjusted** | | | | | | | | |
| Approach 1 | 5.41(1.0)A | 5.4(1.01)A | 5.36(1.01)A | 5.45(1.01)A | 5.39(1.01)A | 09391 | 0.1748 | 0.2285 |
| Approach 2 | 5.41(1.01)A | 5.39(1.01)A | 5.41(1.01)A | 5.41(1.01)A | 5.4(1.01)A | 0.8811 | 0.9388 | 0.2253 |
| Approach 3 | 5.41(1.01)A | 5.37(1.01)A | 5.41(1.01)A | 5.43(1.01)A | 5.39(1.01)A | 0.8456 | 0.7698 | 0.2264 |
| **Unadjusted** | | | | | | | |  |
| Approach 1 | 5.47(1.01)B | 5.41(1.01)AB | 5.36(1.01)A | 5.43(1.01)AB | 5.33(1.01)A | 0.0067 | 0.0040 | 0.0096 |
| Approach 2 | 5.48(1.01)A | 5.39(1.01)A | 5.4(1.01)A | 5.39(1.01)A | 5.35(1.01)A | 0.0134 | 0.1149 | 0.0072 |
| Approach 3 | 5.48(1.01)B | 5.38(1.01)AB | 5.39(1.01)AB | 5.42(1.01)AB | 5.34(1.01)A | 0.0195 | 0.0597 | 0.0089 |
| **Apolipoprotein B (g/L)**\*\* (n=1932)  **Adjusted** | | | | | | | | |
| Approach 1 | 0.98(0.02)A | 1.01(0.02)A | 0.99(0.02)A | 0.97(0.02)A | 0.95(0.02)A | 0.1085 | 0.1019 | 0.1751 |
| Approach 2 | 0.99(0.02)A | 1.0(0.02)A | 1.0(0.02)A | 0.97(0.02)A | 0.95(0.02)A | 0.1375 | 0.3346 | 0.1741 |
| Approach 3 | 0.99(0.02)A | 1.0(0.02)A | 0.99(0.02)A | A0.97(0.02)A | 0.95(0.02)A | 0.1003 | 0.3800 | 0.1733 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 1.0(0.02)A | 1.01(0.02)A | 0.98(0.02)A | 0.97(0.02)A | 0.94(0.02)A | 0.0429 | 0.1496 | 0.0073 |
| Approach 2 | 1.01(0.02)A | 0.99(0.02)A | 0.98(0.02)A | 0.98(0.02)A | 0.94(0.02)A | 0.0573 | 0.3683 | 0.0068 |
| Approach 3 | 1.01(0.02)A | 0.99(0.02)A | 0.97(0.02)A | 0.98(0.02)A | 0.95(0.02)A | 0.0611 | 0.3529 | 0.0061 |
| **C-reactive protein (CRP) (mg/L)**\*\* (n=2237)  **Adjusted** | | | | | | | | |
| Approach 1 | 1.4(1.02)AB | 1.16(1.01)A | 1.37(1.03)AB | 1.42(1.02)AB | 1.6(1.03)B | 0.0210 | 0.0083 | 0.2553 |
| Approach 2 | 1.33(1.02)A | 1.24(1.02)A | 1.28(1.02)A | 1.46(1.03)A | 1.63(1.04)A | 0.0179 | 0.1043 | 0.2543 |
| Approach 3 | 1.33(1.02)A | 1.23(1.02)A | 1.35(1.03)A | 1.42(1.02)A | 1.62(1.04)A | 0.0121 | 0.0775 | 0.2532 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 1.44(1.03)AB | 1.11(1.01)A | 1.34(1.03)AB | 1.46(1.03)AB | 1.61(1.04)B | 0.0245 | 0.0107 | 0.0138 |
| Approach 2 | 1.39(1.03)A | 1.21(1.02)A | 1.17(1.01)A | 1.5(1.04)A | 1.7(1.05)A | 0.0153 | 0.0304 | 0.0175 |
| Approach 3 | 1.38(102)A | 1.2(1.01)A | 1.22(1.02)A | 1.5(1.03)A | 1.68(1.05)A | 0.0105 | 0.0376 | 0.0143 |

\* Values are reported as x̅ | SEM  
† Means sharing capital letters within rows are not statistically significant from each other. Significance is determined at P<0.005 (Pairwise comparison with Bonferroni correction for multiple comparisons)  
‡ P-value for linear trend. A significance is determined at *p* <0.05  
§ P-value for significant difference determined through test for equality of means. Significance is determined at p<0.05  
‖ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, and area remoteness  
¶ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, Na intake, and BMI  
\*\* Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, saturated fat intake, monounsaturated fat, polyunsaturated fat intake, trans saturated fat intake, alcohol intake, and BMI  
†† Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, saturated fat intake, monounsaturated fat, polyunsaturated fat intake, trans saturated fat intake, free sugar intake, alcohol intake, and BMI  
‡‡ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, free sugar intake, and BMI

*Quintiles sharing capital letters within rows are not statistically significant from each other. Comparison of means were conducted through pairwise comparison. All comparisons applied a Bonferroni correction or multiple comparisons such that a significant difference was observed at P <0.005.*

**Supplementary Material 10.** Association between quintiles of energy intake (%E) from ultra-processed food (UPF) and cardiometabolic risk measures relevant to T2D for whole-grain modified UPF definitions in Australian adults with1d of intake and excluding T2D (n=254).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Proportion of energy intake from UPF (%) a** | | | | | P-value for linear trendb | P-value for sig. differencec | Adjusted R-squared |
| Q1 | Q2 | Q3 | Q4 | Q5 |
| **Body weight (kg)||** (n=5833)  **Adjusted** | | | | | | | | |
| Approach 1 | 74.9(0.6)A | 75.8(0.6)AB | 76.3(0.6)AB | 77.0(0.6)AB | 77.8(0.6)B | 0.0003 | 0.0120 | 0.2249 |
| Approach 2 | 74.7(0.5)A | 76.2(0.7)AB | 76.3(0.6)AB | 76.9(0.6)B | 77.8(0.6)B | 0.0005 | 0.0061 | 0.2251 |
| Approach 3 | 74.9(0.5)A | 75.9(0.6)AB | 76.2(0.5)AB | 76.9(0.6)AB | 77.9(0.6)B | 0.0004 | 0.0087 | 0.2252 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 74.8(0.6)A | 75.9(0.6)AB | 76.6(0.7)AB | 76.9(0.7)AB | 77.6(0.6)B | 0.0017 | 0.0364 | 0.0032 |
| Approach 2 | 74.7(0.6)A | 76.3(0.7)AB | 76.5(0.6)AB | 76.8(0.7)AB | 77.6(0.6)B | 0.0022 | 0.0256 | 0.0032 |
| Approach 3 | 75.0(0.6)A | 75.8(0.7)AB | 76.4(0.6)AB | 76.7(0.6)AB | 77.8(0.7)B | 0.0021 | 0.0501 | 0.0030 |
| **BMI (kg/m2)||** (n=5800)  **Adjusted** | | | | | | | | |
| Approach 1 | 26.0(0.2)A | 26.5(0.2)AB | 26.6(0.2)AB | 26.7(0.2)AB | 27.1(0.2)B | <0.0001 | 0.0011 | 0.0882 |
| Approach 2 | 26.0(0.2)A | 26.5(0.2)AB | 26.5(0.2)AB | 26.7(0.2)AB | 27.1(0.2)B | 0.0001 | 0.0014 | 0.0879 |
| Approach 3 | 26.0(0.2)A | 26.5(0.2)AB | 26.5(0.2)AB | 26.6(0.2)AB | 27.2(0.2)B | 0.0001 | 0.0011 | 0.0885 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 26.2(0.2)A | 26.7(0.2)A | 26.7(0.2)A | 26.5(0.2)A | 26.8(0.2)A | 0.0598 | 0.1073 | 0.0017 |
| Approach 2 | 26.2(0.2)A | 26.6(0.2)A | 26.7(0.2)A | 26.5(0.2)A | 26.7(0.2)A | 0.1174 | 0.1577 | 0.0014 |
| Approach 3 | 26.2(0.2)A | 26.6(0.2)A | 26.7(0.2)A | 26.5(0.2)A | 26.8(0.2)A | 0.0678 | 0.1017 | 0.0017 |
| **Waist circumference (cm)||** (n=5734)  **Adjusted** | | | | | | | | |
| Approach 1 | 89.9(0.4)A | 90.7(0.5)AB | 91.3(0.5)AB | 91.2(0.5)AB | 92.2(0.5)B | 0.0008 | 0.0120 | 0.2557 |
| Approach 2 | 89.9(0.4)A | 90.7(0.5)AB | 91.0(0.5)AB | 91.4(0.5)AB | 92.3(0.6)B | 0.0003 | 0.0082 | 0.2559 |
| Approach 3 | 90.0(0.4)A | 90.5(0.5)AB | 91.0(0.4)AB | 91.4(0.5)AB | 92.4(0.6)B | 0.0002 | 0.0066 | 0.2562 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 90.5(0.5)A | 91.6(0.6)A | 91.8(0.5)A | 09.5(0.6)A | 90.8(0.6)A | 0.7272 | 0.2747 | 0.0016 |
| Approach 2 | 90.7(0.5)A | 91.4(0.7)A | 91.6(0.5)A | 90.7(0.5)A | 90.8(0.6)A | 0.7535 | 0.6623 | 0.0007 |
| Approach 3 | 90.9(0.5)A | 91.1(0.6)A | 91.6(0.5)A | 90.7(0.5)A | 90.9(0.6)A | 0.8496 | 0.7581 | 0.0005 |
| **Waist:height ratio||** (n=5708)  **Adjusted** | | | | | | | | |
| Approach 1 | 0.5 (0.003)A | 0.5(0.003)AB | 0.5(0.003)AB | 0.5(0.003)AB | 0.5(0.003)B | 0.0006 | 0.0069 | 0.2193 |
| Approach 2 | 0.5(0.002)A | 0.5(0.003)AB | 0.5(0.003)AB | 0.5(0.003)AB | 0.5(0.004)B | 0.0003 | 0.0112 | 0.2192 |
| Approach 3 | 0.5(0.002)A | 0.5(0.003)AB | 0.5(0.003)AB | 0.5(0.003)AB | 0.5(0.004)B | 0.0002 | 0.0059 | 0.2196 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 0.5(0.003)A | 0.5(0.004)A | 0.5(0.003)A | 0.5(0.003)A | 0.5(0.004)A | 0.0927 | 0.0531 | 0.0031 |
| Approach 2 | 0.5(0.003)A | 0.5(0.004)A | 0.5(0.003)A | 0.5(0.003)A | 0.5(0.004)A | 0.1185 | 0.2279 | 0.0017 |
| Approach 3 | 0.5(0.003)A | 0.5(0.003)A | 0.5(0.003)A | 0.5(0.003)A | 0.5(0.004)A | 0.1738 | 0.2322 | 0.0017 |
| **Fasting triglycerides (mmol/L)** †† (n=2269)  **Adjusted** | | | | | | | | |
| Approach 1 | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.0(1.0)A | 1.1(1.0)A | 0.8556 | 0.4542 | 0.2167 |
| Approach 2 | 1.1(1.0)A | 1.0(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.6750 | 0.2556 | 0.2183 |
| Approach 3 | 1.1(1.0)A | 1.0(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.7521 | 0.6189 | 0.2162 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.0(1.0)A | 1.1(1.0)A | 0.5997 | 0.5635 | 0.0033 |
| Approach 2 | 1.1(1.0)A | 1.0(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 0.8459 | 0.4477 | 0.0044 |
| Approach 3 | 1.1(1.0)A | 1.0(1.0)A | 1.1(1.0)A | 1.1(1.0)A | 1.0(1.0)A | 0.9774 | 0.7365 | 0.0022 |
| **Fasting blood glucose (mmol/L)**‡‡(n=2269)  **Adjusted** | | | | | | | | |
| Approach 1 | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 5.0(1.0)A | 4.9(1.0)A | 0.9271 | 0.6042 | 0.2565 |
| Approach 2 | 5.0(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 0.7924 | 0.7988 | 0.2562 |
| Approach 3 | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 0.8932 | 0.8723 | 0.2558 |
| **Unadjusted** | | | | | | | | |
| Approach 1 | 5.0(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 0.1559 | 0.2832 | 0.0032 |
| Approach 2 | 5.0(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 0.1745 | 0.3437 | 0.0036 |
| Approach 3 | 5.0(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 4.9(1.0)A | 0.1538 | 0.2986 | 0.0037 |
| **HbA1c (%)**‡‡ (n=2663)  **Adjusted** | | | | | | | | |
| Approach 1 | 5.3(1.0)A | 5.3(1.0)A | 5.3(1.0)A | 5.4(1.0)A | 5.3(1.0)A | 0.5378 | 0.3027 | 0.2747 |
| Approach 2 | 5.4(1.0)A | 5.3(1.0)A | 5.3(1.0)A | 5.4(1.0)A | 5.3(1.0)A | 0.7655 | 0.1954 | 0.2742 |
| Approach 3 | 5.3(1.0)A | 5.3(1.0)A | 5.3(1.0)A | 5.4(1.0)A | 5.3(1.0)A | 0.6546 | 0.1365 | 0.2753 |
| **Unadjusted** | | | | | | | |  |
| Approach 1 | 5.4(1.0)B | 5.4(1.0)AB | 5.3(1.0)A | 5.3(1.0)AB | 5.3(1.0)A | 0.0009 | 0.0031 | 0.0145 |
| Approach 2 | 5.4(1.0)B | 5.3(1.0)AB | 5.3(1.0)AB | 5.3(1.0)AB | 5.3(1.0)A | 0.0009 | 0.0105 | 0.0120 |
| Approach 3 | 5.4(1.0)B | 5.3(1.0)AB | 5.3(1.0)AB | 5.3(1.0)AB | 5.3(1.0)A | 0.0007 | 0.0034 | 0.0140 |

\* Values are reported as x̅ | SEM  
† Means sharing capital letters within rows are not statistically significant from each other. Significance is determined at P<0.005 (Pairwise comparison with Bonferroni correction for multiple comparisons)  
‡ P-value for linear trend. A significance is determined at *p* <0.05  
§ P-value for significant difference determined through test for equality of means. Significance is determined at p<0.05  
‖ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, and area remoteness  
†† Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, saturated fat intake, monounsaturated fat, polyunsaturated fat intake, trans saturated fat intake, free sugar intake, alcohol intake, and BMI  
‡‡ Age, sex, education, physical activity level, smoking status, socio-economic status, country of birth, area remoteness, free sugar intake, and BMI

*Quintiles sharing capital letters within rows are not statistically significant from each other. Comparison of means were conducted through pairwise comparison. All comparisons applied a Bonferroni correction or multiple comparisons such that a significant difference was observed at P <0.005*