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| **Study** | **Findings (Case vs. Control)** | **Case population studied** | **Metabolic syndrome (MS) criteria** |
| (Kamaura et al., 2010) | ↑ Alanine↑ Arginine↑ Glutamate↑ Leucine↑ Phenylalanine↑ Proline↑ Tyrosine↑ Valine↓ Glycine↓ Serine | Adults who met MS criteria | waist circumference ≥ 85 cm for males or > 90 cm for females AND ≥ 2 of the following 3 criteria: fasting glucose ≥ 110 mg/dL; systolic BP ≥ 130 mm Hg and/or diastolic BP ≥ 85 mm Hg; TG ≥ 150 mg/dL and/or HDL-cholesterol < 40 mg/dL. |
| (Wiklund et al., 2014) | ↑ Alanine↑ Isoleucine↑ Leucine↑ Phenylalanine↑ Tyrosine | Premenopausal adult women with BMI 25-40 kg/m2 who met MS criteria | at least 3 of the following 5 criteria: waist circumference of ≥ 88 cm; fasting serum TG ≥ 1.7 mmol/L; fasting HDL-cholesterol < 1.30 mmol/L, fasting glucose ≥ 5.6 mmol/L and blood pressure ≥ 130/85 mm Hg. |
| (Yamakado et al., 2015) | ↑ Alanine↑ Isoleucine↑ Leucine↑ Tyrosine↓ Serine | Adults who have MS criteria | waist circumference of ≥ 85 cm for males or > 90 cm for females and ≥ 2 of the following 3 criteria: fasting plasma glucose ≥ 110 mg/dL or the use of medication for diabetes; systolic BP ≥ 130 mm Hg and/or diastolic BP ≥ 85 mm Hg or the use of antihypertensive medication; TG ≥ 150 mg/dL and/or HDL-cholesterol < 40 mg/dL or the use of medication for dyslipidemia. |
| (Chen et al., 2015) | Significantly different:Valine | Metabolically abnormal obese adults with BMI > 25 kg/m2 | BMI > 25 kg/m2 and one or more abnormal metabolic indices (fasting blood glucose > 100 md/dL, TG > 150 mg/dL, HDL-cholesterol < 40 mg/dL in males or < 50 mg/dL in females, systolic BP > 130 mm Hg or diastolic BP > 85 mm Hg). |
| (Gao et al., 2016) | ↑ Alpha-aminoadipate↑ Isoleucine↑ Leucine↑ Valine↑ Propionylcarnitine | Metabolically unhealthy centrally obese adults | 1) HOMA-IR>4.27 (90th percentile), 2) HDL-cholesterol < 1.03 mM in mmol/L in men and < 1.30 mmol/L in women, 3) fasting blood glucose > 5.6 mmol/L, and 4) waist circumference > 102 cm in men and > 88 cm in women. |
| (Mangge et al., 2016) | ↑ Arginine (OB)↑ Phenylalanine (OW and OB)↑ Tyrosine (OW and OB)↑ Valine (OW and OB)↓ Citrulline (LN)↓ Glycine (LN)\*See below | Adults with MS | ≥ 2 of the following: (1) impaired fasting glucose ≥ 126 mg/dL; (2) systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg; (3) TG ≥ 150 mg/dL; (4) HDL-cholesterol < 40 mg/dL in males or < 50 mg/dL in females; and insulin resistance (HOMA-IR >5). |
| (Sun et al., 2016) | ↑ C0↑ C3, 4, 5, 5:1, 5OH↑ C8:1↑ C14OH, 16, 18, 18:1, 18:2, 18OH, 20:4↓ 3-dehydroxy and 3-dehydroC0↓ C7DC↓ 3-dehydroxy and 3-dehydroC0↓ C7DC↓ C12, 12:1 | Adults with MS | Updated ATP III criteria for Asian Americans |

\*Parentheses refer to comparisons of metabolically unhealthy to metabolically healthy individuals within a specified BMI category (LN=lean, OW=overweight, OB=obese).