Obesity

Indications

Overweight and obesity is a global problem and is defined as abnormal or excessive fat accumulation that may impair health (1). Even though this is a preventable disease, prevalence has more than doubled since 1980 (1). Overweight and obesity is defined based on body mass index (BMI). The standard calculation for BMI is weight in kg/height in m^2 (2). BMI classifications are (2);

- Healthy weight: 18.5 - 24.9
- Overweight: 25 - 29.9
- Obesity I: 30 - 34.9
- Obesity II: 35 - 39.9
- Obesity III: 40 and above

The World Health Organisation state that in 2014 more than 1.9 billion adults were overweight and of those 600 million were obese (1).

Raised BMI is a major risk factor for diseases such as cardiovascular disease, type II diabetes, musculoskeletal disorders, some cancers (endometrial, breast and colon) (1), fatty liver disease, gallstones and gastro-oesophageal disease as well as psychological and psychiatric disorders (2). The cost of being overweight and obese to society is estimated to be around £16 billion in 2007 and could increase to around £50 billion by 2050 (2).

Although BMI is the recommended method of assessment, caution is advised with its interpretation due to its lack of direct measurement of adiposity. NICE recommends using waist circumference as an additional measure in people with BMI lower than 35 to assess health risks associated with overweight and obese (2). For men, waist circumference of less than 94 cm is low, 94–102 cm is high and more than 102 cm is very high. For women, waist circumference of less than 80cm is low, 80-88 is high and more than 88cm is very high (2).

Testing routinely offered via the NHS includes, fasting lipid profile, blood pressure and HbA1c (2).

Patients are tiered based on their BMI, waist circumference and presenting comorbidities (see table below).

BMI classification	Waist circumference			Comorbidities present
	Low	High	Very high	
Overweight	1	2	2	3
Obesity I	2	2	2	3
Obesity II	3	3	3	4

BMI classification	Waist circumference			Comorbidities present
Obesity III	4	4	4	4

Intervention is based on the tier a person falls into (2);
1 - General advice on health weight and lifestyle
2 - Diet and physical activity
3 - Diet and physical activity; consider drugs
4 - Diet and physical activity; consider drugs; consider surgery

Routine NHS testing allows for assessing cardiovascular risk based on total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides and assessing pre diabetes and diabetes via measurement of HbA1c, both of which are important measures for assessing comorbidities. Thinking functionally, when we consider the interconnected nature of the human body, there may be many other factors that prove clinically significant in assessing overall health and risk of comorbidities in the overweight and obese individual. Additional nutritional and functional testing therefore may be applicable and prove beneficial in the following areas;

Screening
Factors such as thyroid function (3), gut microbiome (4), stress (5) and mitochondrial health (6) may be linked with an increased risk for overweight/obesity. Functional testing may be beneficial, therefore, in obesity prevention.

Post diagnosis
Nutritional and functional testing may be beneficial in addition to mainstream testing methods (outlined above) for post diagnosis and may be supportive to intervention decisions. These tests may also prove beneficial for people falling into tier 1 and 2, not yet presenting with comorbidities.

Recommended Tests

C Reactive Protein (CRP)
CRP is a marker of inflammation and has been shown to predict incidence of myocardial infarction, stroke, peripheral vascular disease and sudden cardiac death (7). Adipose tissue produces pro inflammatory cytokines including IL-6 which is a stimulator of CRP production in the liver (8). Furthermore weight loss has been shown to reduce CRO levels (9).
[Sample requirement: clotted blood tube (gold top)]

Homocysteine (Hcy)
Hcy is an independent risk factor for atherothrombotic and thromboembolic disease (10). An inverse correlation between between obesity and Hcy levels has been shown (10), not surprisingly this also correlated with folic acid levels (see vitamin profile).
[Sample requirement: EDTA (lavender top)]

Thyroid profile
Hypothyroidism has long been associated with weight increase and decrease in basal metabolic rate and thermogenesis (11). Free thyroxine has also shown an inverse correlation with BMI (11). Evidence suggests that even slight variations in thyroid function (free T4, TSH) may contribute to obesity and the tendency to weight gain (3).
[Sample requirement: clotted blood tube (gold top)]

Plasma Mineral Profile with Red Cell Magnesium
Obese individuals are more likely to have low blood levels and/or lower bioavailability of minerals (20). Research suggests that supplementation with a multi vitamin and mineral may reduce body weight and

improve lipid profiles (21). Multi vitamin and mineral supplementation has also been shown to reduce CRP and blood pressure in obese women (21).
[Sample requirement: Trace element free plasma (navy blue top tube), heparin [green top] and clotted blood tube (gold top)]

Iodine - urine
Obesity has been shown to be an independent risk factor for iodine deficiency (12). Moderate to severe Iodine deficiency in overweight women has been associated with elevated serum TSH resulting in an atherogenic lipid profile and increased risk of hypercholesterolemia (13). Furthermore iodine supplementation was shown to reduce hypercholesterolemia in the same group of overweight women (13).
[Sample requirement: random, mid-stream, urine specimen]

Vitamin profile plus Vit D, B12 and folate
Obese individuals are more likely to have low blood levels and/or lower bioavailability of vitamins (20). Specifically, low concentrations of Vitamin B6, C, Vitamin D and E were found in obese patients (22). Obesity related Vitamin D deficiency may be due to a decreased bioavailability of vitamin D due to deposition in body fat (23). Research suggests that supplementation with a multi vitamin and mineral may reduce body weight and improve lipid profiles (20). Multi vitamin and mineral supplementation has also been shown to reduce CRP and blood pressure in obese women (21).
[Sample requirements: clotted blood tube (gold top) for fat soluble vitamins & B12, heparin (green top) for B vitamins and EDTA (lavender top) for folate]

Fatty Acids - Erythrocytes
The ratio of omega 6 and 3 fatty acids have been shown to be important for cardiovascular health. In addition it is hypothesised that EPA/DHA may reduce adiposity via increasing lipid oxidation, mediate insulin sensitivity, even in the presence of increased fat mass, and may modulate adipokine secretion from adipose tissue (14).
[Sample requirement: EDTA (lavender top)]

Antioxidant profile
Disruption of mitochondrial function has been shown in obesity and linked with an increase of reactive oxygen species (ROS), damaging mitochondria and affecting ATP production (6). This increase in ROS production is accompanied by a decreased expression of antioxidant enzymes such as superoxide dismutase and glutathione peroxidase (15).
[Sample requirements: clotted blood tube (gold top) and heparin (green top), to reach the laboratory within 24 hours of collection]

Microbiology (stool)
The gut microbiota is known to participate in the body's metabolism by affecting energy balance, glucose metabolism and inflammation (4). Obesity has been associated with dysbiosis via the increased ability to harvest energy from the diet (4). A shift between the ratio of firmicutes and bacteroidetes seem important with decreased bacteroidetes associated with obesity (4,16,17). Probiotics may be important in preventing dysbiosis associated with obesity (18).
[* Sample collection kit available on request]

Toxic Organic Chemical Exposure Profile
Environmental toxins have been associated with mitochondrial damage resulting in altered function (19). Altered mitochondrial function and energy production may be responsible for an increased risk, and progression, of obesity (6). Impaired ability to oxidise fatty acids for energy has been shown in pre-obese and obese people (6).
[* Sample requirement: Mid-stream, early morning, urine specimen]

Adrenal stress
Hyper activation of the HPA axis has been implicated in the development of obesity (24).
[Sample requirement: random, mid-stream, urine specimen]

Patient preparation

Patients should avoid mineral and vitamin supplements for 24-48 hours prior to providing blood & urine samples for above tests and should follow any other individual test instructions provided with test kits.

Turn around time

Typically 3-5 working days for tests performed at Biolab, but up to 15 working days for samples referred to laboratories outside of the UK (*)

Prepared by Hayley Jones on behalf of Biolab (Nov 2015)

References

1. Anon, WHO | Obesity and overweight. Available at: http://www.who.int/mediacentre/factsheets/fs311/en/ [Accessed October 26, 2015].
2. Anon, Obesity: identification, assessment and management | 1-Recommendations | Guidance and guidelines | NICE. Available at: https://www.nice.org.uk/guidance/cg189/chapter/1-recommendations#assessment [Accessed October 20, 2015].
3. Biondi, B., 2010. Thyroid and obesity: an intriguing relationship. The Journal of clinical endocrinology and metabolism, 95(8), pp.3614–7. Available at: http://press.endocrine.org/doi/full/10.1210/jc.2010-1245 [Accessed October 12, 2015].
4. Brown, K. et al., 2012. Diet-induced dysbiosis of the intestinal microbiota and the effects on immunity and disease. Nutrients, 4(8), pp.1095–119. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3448089&tool=pmcentrez&rendertype=abstract [Accessed December 8, 2014].
5. Vicennati, V. et al., 2009. Stress-related development of obesity and cortisol in women. Obesity (Silver Spring, Md.), 17(9), pp.1678–83. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19300426 [Accessed October 25, 2015].
6. Rogge, M.M., 2009. The role of impaired mitochondrial lipid oxidation in obesity. Biological research for nursing, 10(4), pp.356–73. Available at: http://brn.sagepub.com/content/10/4/356.short?rss=1&ssource=mfr [Accessed August 31, 2015].
7. Aronson, D. et al., 2004. Obesity is the major determinant of elevated C-reactive protein in subjects with the metabolic syndrome. International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity, 28(5), pp.674–9. Available at: http://dx.doi.org/10.1038/sj.ijo.0802609 [Accessed October 25, 2015].
8. Visser, M., 1999. Elevated C-Reactive Protein Levels in Overweight and Obese Adults. JAMA, 282(22), p.2131. Available at: http://jama.jamanetwork.com/article.aspx?articleid=192183 [Accessed August 29, 2015].
9. Tchernof, A., 2002. Weight Loss Reduces C-Reactive Protein Levels in Obese Postmenopausal Women. Circulation, 105(5), pp.564–569. Available at: http://circ.ahajournals.org/content/105/5/564.full [Accessed October 25, 2015].
10. Vayá, A. et al., 2012. Homocysteine levels in morbidly obese patients: its association with waist circumference and insulin resistance. Clinical hemorheology and microcirculation, 52(1), pp.49–56. Available at: http://www.researchgate.net/publication/223989028_Homocysteine_levels_in_morbidly_obese_patients._Its_association_with_waist_circumference_and_insulin_resistance [Accessed October 25, 2015].
11. Longhi, S. & Radetti, G., 2013. Thyroid function and obesity. Journal of clinical research in pediatric endocrinology, 5 Suppl 1, pp.40–4. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3608008&tool=pmcentrez&rendertype=abstract [Accessed August 15, 2015].
12. Lecube, A. et al., 2015. Iodine deficiency is higher in morbid obesity in comparison with late after bariatric surgery and non-obese women. Obesity surgery, 25(1), pp.85–9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/24908244 [Accessed August 28, 2015].
13. Herter-Aeberli, I. et al., 2015. Iodine Supplementation Decreases Hypercholesterolemia in Iodine-Deficient, Overweight Women: A Randomized Controlled Trial. The Journal of nutrition, 145(9), pp.2067–75. Available at: http://jn.nutrition.org/content/early/2015/07/22/jn.115.213439 [Accessed October 25, 2015].
14. Kalupahana, N.S., Claycombe, K.J. & Moustaid-Moussa, N., 2011. (n-3) Fatty acids alleviate adipose tissue inflammation and insulin resistance: mechanistic insights. Advances in nutrition (Bethesda, Md.), 2(4), pp.304–16. Available at: http://advances.nutrition.org/content/2/4/304.full [Accessed October 22, 2015].

15. Albuali, W.H., 2014. Evaluation of oxidant-antioxidant status in overweight and morbidly obese Saudi children. World journal of clinical pediatrics, 3(1), pp.6–13. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4145643&tool=pmcentrez&rendertype=abstract [Accessed October 25, 2015].
16. Cani, P.D. & Delzenne, N.M., 2009. Interplay between obesity and associated metabolic disorders: new insights into the gut microbiota. Current opinion in pharmacology, 9(6), pp.737–43. Available at: http://www.sciencedirect.com/science/article/pii/S1471489209000927 [Accessed July 19, 2015].
17. Shen, J., Obin, M.S. & Zhao, L., 2013. The gut microbiota, obesity and insulin resistance. Molecular aspects of medicine, 34(1), pp.39–58. Available at: http://www.sciencedirect.com/science/article/pii/S0098299712001288 [Accessed July 11, 2014].
18. Lee, S.J. et al., 2014. The effects of co-administration of probiotics with herbal medicine on obesity, metabolic endotoxemia and dysbiosis: a randomized double-blind controlled clinical trial. Clinical nutrition (Edinburgh, Scotland), 33(6), pp.973–81. Available at: http://www.sciencedirect.com/science/article/pii/S0261561413003294 [Accessed September 11, 2015].
19. Meyer, J.N. et al., 2013. Mitochondria as a Target of Environmental Toxicants. Toxicological Sciences, 134(1), pp.1–17. Available at: http://toxsci.oxfordjournals.org/content/early/2013/05/22/toxsci.kft102.full [Accessed October 21, 2015].
20. Li, Y. et al., 2010. Effects of multivitamin and mineral supplementation on adiposity, energy expenditure and lipid profiles in obese Chinese women. International Journal of Obesity, 34(6), pp.1070–1077. Available at: http://dx.doi.org/10.1038/ijo.2010.14 [Accessed October 11, 2015].
21. Wang, C. et al., 2009. Effects of supplementation with multivitamin and mineral on blood pressure and C-reactive protein in obese Chinese women with increased cardiovascular disease risk. Asia Pacific journal of clinical nutrition, 18(1), pp.121–30. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19329405 [Accessed October 25, 2015].
22. Aasheim, E.T. et al., 2008. Vitamin status in morbidly obese patients: a cross-sectional study. Am J Clin Nutr, 87(2), pp.362–369. Available at: http://ajcn.nutrition.org/content/87/2/362.full [Accessed October 25, 2015].
23. Wortsman, J. et al., 2000. Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr, 72(3), pp.690–693. Available at: http://ajcn.nutrition.org/content/72/3/690.abstract [Accessed October 25, 2015].
24. Lubrano C, Genovesi G, Specchia P, et al. Obesity and Metabolic Comorbidities: Environmental Diseases? Oxidative Medicine and Cellular Longevity, vol. 2013, Article ID 640673, 9 pages, 2013. http://www.hindawi.com/journals/omcl/2013/640673/

Advisory note:

This guide to a disease specific recommended panel of tests, lists those nutritional & biochemical pathology investigations that are justified in current medical literature and which may be appropriate for some individuals. These are guidelines only and individual requirements will vary depending on multiple factors (diet, use of nutritional supplements, food exclusions etc).