

Diagnosis and management of Type 2 Diabetes (T2DM) in Children and Young People (CYP): Clinical Practice Guideline



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1. Introduction:

The incidence of Type 2 diabetes (T2DM) in Children and Young People (CYP) is rising globally in parallel with the rising rates of childhood obesity. In 2005, the UK annual incidence of T2DM in CYP < 17 years was 0.53 per 100,000 per year rising to 0.72 per 100,000 per year in 2015. The 2016-17 National Paediatric Diabetes Audit (NPDA)³³ reported that T2DM accounted for 2.5 % of the cohort. A proportionally higher number of cases are seen in adolescent females and CYP from Black and Asian ethnic backgrounds. Additional risk factors associated with T2DM include obesity, positive family history and low socioeconomic status.

Approximately 35% of CYP are asymptomatic at diagnosis with the diagnosis being made after an incidental glucose finding or further investigations for obesity related co-morbidities. Diagnostic challenges do remain as being overweight and obese can also occur in children diagnosed with Type 1 diabetes (T1DM). Diabetic KetoAcidosis (DKA) can be a presenting feature of T2DM with some series reporting a rate up to 25%. Accurate diagnosis of T2DM is critical for appropriate treatment, educational approaches, dietary modification and prevention of adverse outcomes.

T2DM in CYP compared to adults demonstrate unique features such as rapid decline in β cell function and accelerated development of microvascular and macrovascular complications. Non-Alcoholic Fatty Liver Disease (NAFLD), hypertension, dyslipidaemia and microalbuminuria can be present at diagnosis and the prevalence increases with the duration of diabetes. This underlies the importance of screening for all complications and associated co- morbidities including Polycystic Ovarian Syndrome (PCOS), Obstructive Sleep Apnoea (OSA) and psychological co-morbidities.

CYP onset T2DM has become more common, carries a high disease burden and is associated with increased short term and long term morbidity. Early detection, institution of a multi-faceted management approach and early screening and management of complications will help to preserve the future health of the affected individual.

These clinical practice guidelines are based on the best available evidence. It incorporates guidance surrounding diagnosis, initial and subsequent treatment, on-going monitoring and screening for and management of complications.

2. Diagnosis: (according to American Diabetes Association criteria) 8

Diagnosis of T2DM is based on measurement of glucose levels **AND** the presence of symptoms and requires two steps;

- Confirmation of the presence of diabetes, **and**
- Determination of the type (mainly based on typical characteristics)

Any one or more of these symptoms will give a diagnosis of diabetes, further investigations maybe needed for the type of diabetes (T1DM, T2DM, MODY etc).

1. Osmotic symptoms (polyuria, polydipsia, nocturia and unexplained weight loss) with random plasma glucose ≥ 11.1 mmol/L ; **or**
2. Fasting (defined as no caloric intake for at least 8 hours) plasma glucose levels ≥ 7 mmol/L **or**
3. 2 hour plasma glucose ≥ 11.1 mmol/L during an oral glucose tolerance test (OGTT) performed as described by the World Health Organisation; **or**
4. HbA1c equal to or greater than 6.5 % (48mmol/mol) (by equipment calibrated according to International Federation of Clinical Chemistry) but HbA1c is used with caution in the paediatric population as sole means of diagnosis).
5. It is extremely important that a medical professional explains the diagnosis of diabetes to the CYP and family. If determination of type of diabetes is unclear then further investigations will be warranted as determined by the guideline.

Note:

- Asymptomatic CYP may have incidental hyperglycaemia when placed under conditions of acute stress (e.g. surgery, illness, infection). This effect is usually transient and does not constitute a diagnosis of T2DM.
- In the absence of symptoms, testing should be repeated on a different day to confirm abnormal fasting or post prandial glucose levels.
- Diabetes autoantibody testing (GAD54, IA2) should be considered in all CYP at diagnosis but this is especially important in those presenting with DKA or in overweight /obese pubertal children with a clinical picture of T1DM.^{3, 24}

3. Type 2 Diabetes characteristics:²⁹

Characteristics indicative of T2DM include:

- Presentation can vary from asymptomatic hyperglycaemia to ketoacidosis in 25% of patients or Hyperglycaemic Hyperosmolar State (HHS).
- Having a strong family history of T2DM.
- Being obese (BMI equal to greater than 98th percentile for age and gender) at presentation.
- Being of Black or Asian family origin.
- Having no insulin requirement, or having an insulin requirement of less than 0.5 units/kg body weight/day after the partial remission phase.
- Showing evidence of insulin resistance (for example acanthosis nigricans).

Note:

- There is increasing trend of obesity of up to 30% in CYP with T1DM or patients with MODY.²⁴
- DKA occurs in up to 25% of CYP aged 10-19 years with T2DM⁸

Further considerations at diagnosis:

Diagnosis and determination of the diabetes type:

Consider measuring C-peptide after initial presentation (e.g. 6 months) if there is difficulty distinguishing T2DM from other types of diabetes. Be aware that C-peptide concentrations have better discriminative value the longer the interval between initial presentation and the test.²⁹

Diabetes Autoantibodies can be present in 10-20% of those with a clinical diagnosis of T2DM and predicts a rapid development of insulin requirements and also highlights a risk of developing other autoimmune diseases.

Since 4.5 – 8% of CYP with clinical features suggestive of T2DM have been found to have monogenic diabetes, genetic testing for monogenic form should be considered as well.⁸

- A non-fasting (random) blood C-peptide value of equal to or greater than 600pmol/L indicates substantial endogenous insulin secretion and is consistent with hyperinsulinism seen in T2DM. (<http://www.exeterlaboratory.com/images/C-peptide-ranges-2.png>)
- The MODY Probability Calculator can be used for further assessment and is available from <https://www.diabetesgenes.org/mody-probability-calculator/>

The presence of clinically relevant associated complications and comorbidities should be assessed at the time of diagnosis:

History:

History should be obtained about symptoms:

- Obstructive Sleep Apnoea (OSA): night time snoring, day time sleeping
- Pregnancy
- PCOS, irregular periods, hirsutism, acne
- Emotional well-being
- Smoking
- Current diet and activity levels at the time of diagnosis.

Clinical assessment:

At the time of diagnosis, the following should be assessed:

- Measurement of weight, height, BP and calculation of BMI.
- Point of care blood glucose test.
- General and systemic examination
 - To look for signs of insulin resistance (e.g. acanthosis nigricans), liver disease (e.g. xanthomas).

Investigations:

The following investigations should be done at the time of diagnosis:

- A laboratory Blood glucose test.
- HbA1c
- Fasting Lipid profile
- Liver enzymes (LFT).
- Urea and electrolytes (U&E's).
- Blood gas and lactate.
- Consider OGTT only where there is significant diagnostic uncertainty.
- Diabetes autoantibodies (GAD54, IA2) should be considered, if clinically indicated
- Urine albumin/creatinine ratio (ACR).

High triglycerides and reduced HDL-Cholesterol (HDL-C) are the hallmarks of the dyslipidaemia characteristic of insulin resistance and T2DM. Hypertension is associated with endothelial dysfunction, arterial stiffness and increased risk of both cardiovascular and kidney disease.

Hypertriglyceridemia, decreased HDL-C and hypertension can occur in CYP within few months of diagnosis of T2DM. Micro and macroalbuminuria may be present at the time of diagnosis.

LFTs, U&E's may be abnormal at time of diagnosis, especially if the young person presents with metabolic derangement. Consider repeating at the first outpatient visit.

4. Prediabetes: ²⁴

CYP who do not meet the diagnostic criteria for diabetes but are having glucose levels, which are higher than the expected range according to Oral Glucose Tolerance Test (OGTT) values, are at a higher risk of progression to diabetes.

- **IFG:** Impaired fasting glycaemia. Fasting plasma glucose levels 5.6-6.9 mmol/L.
- **IGT:** Impaired glucose tolerance. Post challenge plasma glucose levels 7.8-11.0 mmol/L.
- **HbA1c** 40-46 mmol/mol (5.7% to 6.4%).

Obese adolescents may have transient prediabetes with 60% reverting to normal OGTT levels within 2 years. Persistent weight gain is a predictor for persistent prediabetes and diabetes progression. Review these CYP annually.

Some CYP may have elevated HbA1c levels but normal OGTT, likely to reflect daily carbohydrate intake exceeding that associated with the standard glucose load (75g glucose). ^{8, 24}

Some CYP who meet the criteria for IFG or IGT may be euglycaemic in daily lives with normal HbA1c levels.

Diet and lifestyle modification has been shown to be effective for adolescents with pre diabetes with no evidence for metformin use.

5. Management Goals for T2DM: ²⁴

1. Lifestyle modification
2. Normalisation of glycaemic control
3. Emotional well being
4. Education for diabetes self-management
5. Control of comorbidities (including hypertension, dyslipidaemia, nephropathy, sleep disorders and hepatic steatosis)
6. Smoking cessation

6. Management of T2DM:

6.1 Lifestyle modification including weight loss advice and exercise management:

The main purpose of a lifestyle intervention for those diagnosed with T2DM is to support the whole family, often in making quite substantial changes. These include a focus on healthy eating; looking at a number of specific areas of diet as outlined below, as well as on increasing levels of physical activity and ensuring adequate sleep is attained.

Lifestyle changes can be extremely challenging and having a diabetes dietitian and psychologist as part of the diabetes team is helpful in fostering a non-judgmental approach that supports open dialogue around the motivation and barriers to change as well as the support needed. ⁴²

Lifestyle changes should be tailored to individual family's needs and existing lifestyle, including personal preferences/routine, culture, beliefs, age/ maturity, social circumstances. Support systems should also be established.

Diet:

Education and negotiated goals around dietary change should cover the following areas in relation to T2DM:

- Weight management
- BG management
- Healthy eating to ensure adequate micronutrient intake
- Heart health

Weight management:

Establishing a stable weight should be the immediate aim of lifestyle advice, followed by slow and sustainable weight loss (e.g. 0.5 -1 kg per month) from one month onwards. Explore a variety of different diet options as it is likely to help with finding a plan that is a best fit to the individual family's structure and needs.

Examples include:

- A reduced or moderate carbohydrate approach (26-45% of energy).
- Healthy eating with general portion size reduction.
- Attendance at a slimming club may be beneficial. (programmes are available for CYP who attend with a parent/guardian)

A pilot study on very low calorie diets (VLCDs) in adolescents has been carried out²⁰ but it is considered too early to make recommendations in this area. Eligibility for this diet needs defining and further experience in this area will allow for future recommendations.

The aim needs to be to choose a sustainable option that provides an energy deficit of around 300- 500 kcal depending on the CYP's weight/BMI at diagnosis.

Consider increasing both fibre and protein in the diet as it may make it easier to reduce overall meal time portion sizes.⁹ Care does need to be taken not to increase total energy intake if encouraging a higher protein intake to increase satiety.

Combining food diaries with recording mood, triggers for over-eating, activities and exercise may be useful for more detailed discussions around behaviour change.

Blood glucose management (BG):

Education should be offered on carbohydrate awareness, as it is the key nutrient that affects post meal BG levels as well as portion sizes.

Making associations between diet and BG levels can be encouraged by:

- Facilitating recording (food diary may help or APPs for recording such as MyFitness Pal)
- Association between quantity and frequency of food with BG excursions
- Educating the families on the concept of Glycaemic Index (GI) of carbohydrates

Food diaries will help to determine an appropriate number of meals and snacks per day, which will also depend upon the diabetes treatment option and on individual preference. The total energy intake recommended can be broken down accordingly across the day. The intake of diet that has carbohydrate with low/medium GI may improve HbA1C up to 0.5%.⁴⁰

Healthy eating and key nutrients:

Vitamin D, B12 and magnesium are of particular importance in T2DM.

Vitamin D:

A systematic review and meta-analysis suggests that Vitamin D supplementation showed an increase in serum 25(OH) D and reduced insulin resistance²⁶. Other studies have shown a reduction in average BG levels when deficiency in vitamin D is corrected.³³ Vitamin D deficiency is also linked with depression⁴⁵, which is also very common in T2DM.

Scientific Advisory Committee on Nutrition (SACN) identify that those at particular risk of Vitamin D deficiency include anyone of Asian origin due to darker pigmentation and women whose skin is covered. Those with a higher BMI, with diabetes and who are not physically active or smoke are also more likely to have lower vitamin D levels.³⁶ Most Vitamin D comes from sun exposure. Good dietary sources include oily fish and fortified cereals and margarine; see local Vitamin D guidelines³⁶ for more information.

Vitamin B12:

Although no specific studies have been done in CYP, adults with T2DM appear to have a higher incidence of vitamin B12 deficiency compared to those without¹⁴. If patients are on Metformin and/or if families are vegan or even vegetarian and/or if the young person has hypothyroidism, greater attention should be paid to sources of vitamin B12 in the diet as this is known to be reduced when adhering to these diets and also in those taking Metformin regularly. Good dietary sources of vitamin B12 include eggs, dairy, meat, fish and shellfish as well as fortified cereals. More details on recommended intake and dietary sources are available in [Appendix 4](#).

Magnesium:

If the diet includes a lot of refined carbohydrates and families are not able to add in wholegrain and the diet is low in fruit and vegetables, supplementation may be appropriate but would not be a first line approach as any weight loss programme will encourage an increased intake of these foods. Magnesium supplementation has been shown to improve insulin sensitivity in CYP with T2DM^{10, 28} emphasising the importance of encouraging good sources in the diet. See [Appendix 4](#) for further details of recommendations on dietary sources and nutritional supplementation. Dietary consult from Paediatric diabetes dietitian is recommended for assessment and optimal dietary management. Dietary sources of magnesium include: wholegrains, green leafy vegetables, nuts and beans.

Cardiovascular health:

The key recommendations for promoting a healthy heart are: ^{12, 42}

- Reduce salt intake for its effects on Blood Pressure (BP).
- Include oily fish in the diet for vitamin D and for omega-3 oils.
- Include 5 portions of vegetables or fruit and vegetables as this provides vital micronutrients, fibre and antioxidants.

Exercise:

All CYP should be encouraged to engage in moderately intense activity for 15 minutes a day and gradually building up to 60 minutes every day and in more vigorous activity at least 3 times a week; these activities should result in a faster heartbeat and difficulty carrying on a conversation. Examples include swimming, football; or dancing and exercise DVDs in the privacy of their own homes.

TV/screen time should be reduced to no more than 2 hours per day.¹⁷

For further recommendations on a practical approach to introducing exercise to sedentary young people, [see Appendix 5](#)

Both muscular fitness and cardiorespiratory fitness are independently associated with metabolic risk of insulin resistance and therefore T2DM²⁴ It is worth noting that a 16 week study doing resistance training

twice a week significantly increased insulin sensitivity in overweight adolescents.³⁷

Young people of Indian, Pakistani, Bangladeshi and Chinese background were found to participate in exercise and sports less than the general population^{30,31}. Special efforts should therefore be made to encourage an increase in these populations.

The importance of exercise should be stressed in relation to the following:

- To increase exercise tolerance for heart health as well as utilisation of fat stores through regular aerobic activity, gradually building up to 60 minutes every day.
- A means of reducing post meal BG levels if doing high intensity exercise post meals⁹ and also HbA1C (independently of weight loss).
- A way of burning energy (kcal) and promoting gradual weight loss.
- To decrease BP and cholesterol levels, reducing the risk of cardiovascular morbidity and mortality.
- To improve bone mineral density.
- Improve mood.

Promotion of an active lifestyle can be done in the following ways:

- By encouraging walking to school/college, using the stairs instead of taking the lift etc. Also consider housework as a way of burning energy (kcal). See [appendix 5](#) for examples of energy used.
- Discussing how to decrease hours watching TV, playing games, using iPad, phone etc. to no more than 2 hours a day and find other things to do in free time.
- Encouraging the CYP with T2DM to join local community based exercise programmes and find a sport or type of exercise that they like.
- Provide information on appropriate cards/means of access to exercise at cheaper prices/discounts that may be available via GPs/councils/local leisure centres.
- Encourage the use of APPs that facilitate recording of activity levels and introduce an element of competition– e.g. fit bits or APPs for families or look at schemes such as Couch to 5K.
- Exercise for those CYP on insulin needs to be discussed with an HCP prior to undertaking. See [Appendix 5](#) for further details of recommended insulin adjustments around exercise.

6.2 Sleep:

Children who don't get the recommended period of sleep are more likely to be overweight. Teenagers should sleep from 8 to 10 hours per 24 hours to promote optimal health, weight and BG management.^{32, 44} There is some evidence to suggest that good quality sleep is associated with a lower HbA1c in adults with T2DM²⁵

Suggestions on how to achieve the recommended sleeping time are³⁸

- For screens to be turned off at least 30 minutes before bedtime.
- Keep TV and computers out of the bedroom.
- Keep room cool, dark and quiet.
- Avoid caffeine.
- Dim the lights and undertake calm activities such as reading.

6.3 Glycaemic Control:

Self-Monitored Blood Glucose (SMBG):^{7, 8, 24}

Unlike in T1DM, the evidence that SMBG has an impact on glycaemic control in the individual with T2DM is limited. However they are essential if a CYP is on a glucose-lowering agent such as insulin, to help recognise,

treat, and avoid hypos.

SMBG should be performed regularly. The frequency of SMBG should be individualised, and include a combination of fasting and postprandial glucose measurements with a frequency based on the degree of glycaemic control and available resources.

During acute illness or when symptoms of hyper or hypoglycaemia occur, patients should perform more frequent testing and be in contact with their diabetes care team for advice.

Patients on insulin need to monitor for asymptomatic hypoglycaemia.

Although normoglycaemia may be difficult to achieve in adolescents with T2DM, a fasting BG level of 4mmol/L to 7mmol/L is a reasonable target for most. Targets for 2-hour post-meal and bedtime/overnight optimal BG levels are 5 – 9 mmol/L.

Treatment regime	Recommended SMBG monitoring
1. Newly diagnosed until metabolic control is achieved.	Before all meals (including a morning fasting BG), 2 hours post-meals and at bedtime.
2. After metabolic control is achieved	
2a) On Oral agents only	Individualised with combination of pre and 2-hour-post-meal testing guided by their diabetes team.
2b) Single long-acting insulin only	Daily fasting/pre-breakfast BG and thrice weekly 2 hours post-meals
2c) Oral agent (e.g. Metformin) plus a single injection of a long-acting insulin	Twice daily BG monitoring (fasting and 2-hour post-meals).
2d) Multiple Daily Insulin (e.g. basal bolus regimen)	Thrice daily BG monitoring (before every meal) and bedtime testing.

HbA1c Monitoring: ^{7, 8, 29, 34}

The current recommendation is to measure HbA1c every 3 months and to aim for an HbA1c level of less than 53 mmol/mol (7% ^{DCCT}) to minimise the risk of long-term risk of complications. ²⁴

Healthcare professionals should agree an individualised lowest achievable HbA1c target with each CYP with T2DM and their family members or carers (as appropriate), taking into account factors such as daily activities, individual life goals, emotional well-being, complications and comorbidities.

Diabetes services should regularly audit the proportion of CYP with T2DM in a service who achieve an HbA1c level of 53 mmol/mol (7%) or lower.

6.4 Pharmacological therapy: ^{8, 24}

Treatment depends on glycaemic control at diagnosis. Currently, **Metformin and Insulin** are the only approved pharmacological therapies in children.

Initial Treatment:

If HbA1c < 69.4 mmol/L (8.5%) and metabolically stable at diagnosis:

- Metformin monotherapy should be commenced. ²⁴ Start with Metformin 500mg once daily and increase by 500mg ;1-2 weekly until 1 gram twice daily (BD). Gastrointestinal side effects are common which may be attenuated by the slow or extended release formula.
- Use of Metformin is contraindicated in the presence of metabolic acidosis. Lactic acidosis is a rare side effect of Metformin. Metformin should be temporarily withdrawn in the presence of risk of dehydration or where there is risk of impaired renal function or tissue hypoxia.

If HbA1c at diagnosis is > 69.4 mmol/L (8.5%) ²⁴:

- Start long-acting basal insulin at 0.25 – 0.5 units/kg/day and escalate to a maximum of 1.5 units/kg/day. Metformin can be started at the same time as insulin, unless acidosis is present.

Once glycaemic control is achieved (HbA1c < 53mmol/L (7%) :

- Basal insulin can be tapered over 2-6 weeks by decreasing the insulin dose by 30 - 50% each time the Metformin is titrated up.

Subsequent Treatment:

The goal of initial treatment should be to attain an HbA1c of less than 7.0% (53mmol/mol) and in some situations <6.5% (48mmol/mol).

- If Metformin were started at the onset and there is poor glycaemic control with failure to obtain a target HbA1c < **7.0%** within 4 months of Metformin monotherapy, basal insulin should be introduced.
- Once both basal insulin (up to 1.5 units/kg/day) and Metformin cannot achieve glycaemic control, rapid acting insulin at meal times may be needed, if 2 hour post meal rise is evident as guided by the individual diabetes teams.

Mealtime insulin:

Consider adding Insulin Aspart at a starting dose of 0.1 unit/kg or 10% of the basal insulin per main meal. Basal and bolus insulin should be titrated once every week to reach a target HbA1c of <7.0%.

It is recommended that a fixed dose regime be used in conjunction with limited carbohydrate portions, calculated by a diabetes dietitian who will estimate the young person's energy requirements and deduct 300-500kcal per day for weight loss. Using a guide of 30-40% of energy from carbohydrates allows the carbohydrates to be split across the day in line with the young person's chosen eating patterns. Unlike in T1DM, carbohydrate counting is discouraged in the management of T2DM as it might not help with weight management.

The fixed dose is calculated by the dietitian using the following ratios as a rough guide (and adjusted accordingly once a food and BG diary is reviewed): 1.5:10g at breakfast, 0.75:10g at lunch, 1:10g at evening meal and 0.75:10g at bedtime snack. The family will receive a fixed insulin plan.

CYP with symptoms of hyperglycaemia at the time of diabetes diagnosis should also be tested for ketosis (blood or urine ketones) and if positive, should then be assessed for ketoacidosis (venous pH), even if their phenotype and risk factor status (obesity, acanthosis nigricans, positive family history of T2DM) suggestive of T2DM. CYP with ketoacidosis must be treated immediately with insulin as per local DKA guidelines.

6.5 Structured Education for diabetes management:

All CYP with T2DM should receive comprehensive education on diabetes management alongside their family from the time of diagnosis. The content will depend upon BG management at diagnosis and treatment commenced. Personal preferences, age and maturity, cultural considerations, emotional well-being, and existing knowledge, beliefs and learning styles of the young person and family should also be taken into consideration.

Dietary and physical activity goals must be established early.

Fundamentals of diabetes theory and practical skills training are essential at diagnosis. Essential explanation should include:

- **Diabetes symptoms:** Diabetes education and an understanding of diabetes symptoms are required of CYP and their families to enable them to understand what T2DM is and how the body uses glucose as energy and how insulin works. They need to know what has gone wrong in the function of their bodies which has caused T2DM. This knowledge is paramount in getting CYP and their families to realise the importance of T2DM management.
- **Blood glucose levels and HbA1c targets:** CYP and their families need to be informed of the daily expected BG range when checking their levels. Daily BG readings should range between 4-7mmols/l pre-meals and 5- 9mmols/l post meals and during the night. Obtaining these levels will help to achieve the target HbA1c of 53mmol/l if there is a risk of recurring hypoglycaemia.²⁹
- **Dietary Review and Assessment:** By a Specialist Diabetes Dietitian including a discussion around any alternative therapies that they may have been recommended as hypoglycaemic agents – e.g. bitter melon, cinnamon etc and the lack of dose control of these treatments. Exploring health beliefs is also important to establish likelihood of adherence to recommended medications.
- **Assessment and Increase of Physical activity:** Indicated above, if the CYP is struggling then make a referral to the local leisure centre to join in relevant programmes such as 'Fun4Life' or 'One You' or similar.
- **Self-Monitoring of Blood glucose levels:** Maintaining dietary and BG diaries. CYP need to be taught how to test their BG levels using a SMBG meter appropriate for their age and abilities. They need to be taught correct technique, safe disposal of sharps and test strips, interpretation of the results and how to manage BG levels out of target – hypoglycaemia and hyperglycaemia.
- **Oral Hypoglycaemic Agent (OHA) medication:** Metformin should be started as clinically indicated. CYP should be aware of their starting dose and possible side-effects of taking Metformin including the risk of gastric irritation. If side effects continue longer than expected then different formulations of metformin can be discussed with the CYP – i.e. tablet, Slow Release tablet or syrup.
- **Insulin therapy:** If glycaemic control cannot be achieved by use of OHA's alone, then insulin injections may be started. If OHA medication and long acting insulin are ineffective then there will be a need to introduce a rapid acting insulin. This should also include the safe storage of insulin and the safe disposal of sharps.
- **Hypoglycaemia symptoms and treatment:** Individualised hypoglycaemia management must be discussed with the CYP according to the age and ability to self-manage a hypo.
- **Information about support groups:** This can include both local and national organisations (e.g. Diabetes UK, JDRF, social media, local support groups, etc).
- **Clinic follow-ups:** x 4 MDT clinics per year in an age appropriate clinic.

- **How to contact the diabetes team:** Emergency contacts for local diabetes team/local hospital must be provided at diagnosis.
- **Medic alert:** Recommended for all CYP who are not reliant on their parents 24/7. There are many different forms of ID that can be obtained from the internet.
- **Contraceptive counselling:** ²⁴ Should include avoiding unplanned pregnancy as well as failure rates. Sexual activity counselling should be for both boys and girls.

6.6 Smoking and substance misuse: ^{8, 24, 29}

Cigarette smoking is harmful to all CYP. CYP with T2DM are especially vulnerable to the negative health consequences of smoking as a result of their compromised health status. Explain about general health problems associated with smoking and in particular vascular complications.

Obtain a smoking history at initial and follow-up diabetes visits, discourage smoking in CYP who do not smoke and offer information about local smoking cessation services in those who smoke.

Explain to CYP with T2DM and their family or carers about general dangers of substance misuse and possible effects on BG control.

6.7 Social and emotional support:

Psychologically based intervention achieves more than didactic education and underpins the development of behavioural and psychosocial approaches to the management of adherence in routine diabetes care. ²¹

Early screening will allow all education and interventions to be appropriately tailored to suit CYP and families. This may prevent CYP and clinicians using effort and resource on inappropriate intervention that may result in failure and loss of motivation. Psychological screening will help identify the barriers to making and sustaining effective change in eating habits for CYP and family. Understanding the family's relationships with food and health, social and cultural influences as well as identifying issues with mood or motivation should enable SMART goals to be set for patients, which can be maintained by the family system. When families have recognised patterns, triggers and vulnerable times in relation to change they have a better chance to maintain healthy lifestyle choices. To avoid generating fear at diagnosis, discussion of seriousness needs to be coupled with an emphasis on treatment effectiveness. Fear is associated with maladaptive coping behaviours, poor control and poor quality of life. Information alone does not elicit behavioural change and so should be tailored to individual needs identified through screening.

- Psychological screening through questionnaires to identify eating behaviours and to screen for low mood as there is an increased risk of depression in type 2 diabetes. ⁴⁶
- If low mood is identified, refer for psychological support.
- Consider offering the newly diagnosed emotional well-being screening appointment, as soon as possible but ideally within 6 weeks following diagnosis. Questionnaires should include family and individual eating behaviours, motivation to change and parenting problems.
- Feedback information to team to inform education program and consultant appointments.
- A sensitive approach should be adopted when using food diaries as this can elicit strong feelings of shame, which may lead to further unhealthy eating if food is a source of comfort. Defensive behaviour resulting from shame may also then disrupt open conversations about food and lead to a breakdown in therapeutic relationship.

- Having a family role model for example a parent completing a weight management programme, may increase self-efficacy⁵ in CYP and improves health behaviours and BMI in overweight and obese CYP³⁹. Active parental involvement should be highly encouraged.

Offer psychological group/family therapy or 1:1 psychological intervention as indicated in addition to education.

6.8 Screening and management of comorbidities and complications:

The following investigations should be done at annual review:

- Liver function tests (LFTs), U&Es
- Thyroid function test (TFT),
- Lipid profile,
- Microalbuminuria,
- Retinopathy screening,
- Neuropathy screening,
- HbA1c.
- Vitamin D levels (to be considered for 'at risk' population, see [page 11](#))

Further screening questions should include:

- Obstructive sleep apnoea (OSA): night time snoring, day time sleeping,
- PCOS: irregular periods, hirsutism, acne,
- Emotional well-being (psychological assessment), e.g. quality of life, adjustment.
- Dietary review.

Microalbuminuria:^{24, 29}

- Urine ACR (Albumin Creatinine Ratio) should be obtained at the time of diagnosis and annually thereafter.
- If the initial urine ACR is above 3mg/mmol but below 30mg/mmol, confirm the result by repeating the test on 2 further occasions on different days over the next three month period using the Early Morning Urine (EMU). If 2 consecutive samples show raised ACR, then treat as per the treatment section of this guideline.
- Consider alternative reasons for excessive albumin in the urine if the following apply:
 - Spurious results due to contamination with menstrual secretions.
 - Associated with Urinary Tract Infection (UTI).
 - Other renal disease (particularly if haematuria, systemic illness or family of renal disease).
 - Orthostatic proteinuria (not passed immediately after rising in the morning, after prolonged standing or exercise).

Ensure that repeat samples are at different times and are midstream.

If urine ACR is elevated to >3mg/mmol in 2 out of 3 early morning urine samples:

- Ensure optimum control diabetes and BP.
- Warn against smoking and provide smoking cessation advice to smokers.
- Start ACE-Inhibitor (ACE-I) or Angiotensin Receptor Blocker (ARB), after discussing with Paediatric/Adult Nephrologist, especially if associated with high BP or if ACR is >30mg/mmol, irrespective of BP. Dose should be titrated every 3 months to full dose until the BP is normalised.
- Adolescent girls must be warned of **teratogenic** potential of ACE-I. Monitor U&E's and creatinine.

Hypertension:

- BP should be checked at diagnosis and monitored at every visit according to standardised techniques specific for CYP.
- A cuff large enough for the child or young person with T2DM should be used when measuring blood pressure.
- Hypertension is defined as an average systolic or diastolic BP >95th percentile for age, sex and height percentiles, with high normal being 90 to <95th percentile. If repeated resting measurements are greater than 95th centile for age and sex, confirm hypertension using 24-hour ambulatory blood pressure monitoring before starting antihypertensive therapy.²⁹

Treatment of hypertension:

- Initial treatment consists of weight loss, limitation of dietary salt, and increased physical activity in liaison with local dietitians.
- If hypertension is confirmed, then an ACE-I or ARB is initiated after discussion with Paediatric Nephrologist/Adult physicians and titrated to achieve BP less than 90th percentile.
- If ACE-I is not tolerated due to adverse effects, an ARB, calcium channel blocker or diuretic can be used after liaising with paediatric nephrologist.
- If hypertension is not responsive to initial medical therapy, a renal ultrasound and echocardiogram should be performed.

Dyslipidaemia:^{24, 29}

- Testing for dyslipidaemia should be done at diagnosis and repeated when glycaemic control has been achieved and annually thereafter.
- Measurements should include total cholesterol, HDL Cholesterol, LDL Cholesterol and triglyceride levels. Dyslipidaemia should be confirmed using a repeat sample (fasting or non-fasting).
- **Definition of dyslipidaemia: (Any of the following)**
 - Total cholesterol >5.5mmol/L,
 - HDL cholesterol < 1.0mmol/L,
 - Ratio of total cholesterol to HDL >4
 - Triglycerides >1.7mmol/L,
 - LDL-cholesterol >2.6 mmol
- Liaise with local dietitian for dietetic input, increase physical activity and optimise glycaemic control.

Statins have been shown to be safe and effective in children as in adults, although long-term safety data is not available. Statins are not approved in pregnancy.

If a repeat lipid profile is persistently high after 6 months of dietetic modification:

- If LDL-C : >2.7 - 3.4mmol/L : maximise non-pharmacologic treatment
- LDL-C : >3.4mmol/L : begin statins with a goal of <3.4mmol/L and an ideal target of <2.6mmol/L

Hypertriglyceridemia:

- If triglycerides >1.7mmol/L: maximise glycaemic control, limit dietary fats and simple sugars, and improve BMI.
- If triglycerides >5.6mmol/L fasting or >11.3mmol/L non-fasting: Begin fibrate therapy with a goal of <1.7mmol/L fasting (to reduce the risk of pancreatitis).

Fibrate therapy is preferred medication category for hypertriglyceridemia and has been shown to be safe and effective. Input from Paediatric/Adult Gastroenterologist should be sought before commencing on fibrate therapy.

Non-Alcoholic Fatty Liver Disease (NAFLD):

Hepatic steatosis is present in 25 – 50% of adolescents with T2DM and more advanced forms of NAFLD, such as Non-Alcoholic SteatoHepatitis (NASH) are increasingly common and associated with progression to cirrhosis, portal hypertension, and liver failure. Liver enzymes can be normal despite the presence of hepatic steatosis. Weight loss improves NAFLD and Metformin improves liver enzymes and liver steatosis.

On-going annual monitoring of LFT's liver enzymes is recommended in CYP with T2DM along with liver ultrasound and ELF test (Enhanced Liver Fibrosis) considered for those with BMI of equal to or greater than 98th centile or those with abnormal liver function.

Consider referral to Paediatric/Adult Hepatologist for further imaging and /or biopsy if liver enzymes remain more than 3 times the upper normal limit despite weight loss and /or diabetes therapies or if abnormal ELF test results.

For those with BMI equal to or greater than 98th centile or those with abnormal LFT's, liver USS and ELF tests are suggested.

Diabetes Retinopathy:²⁹

Explain to CYP with T2DM and their families/carers that background retinopathy may be found through monitoring and improving BG control will reduce the risk of this progressing to sight threatening diabetic retinopathy.

Ensure that CYP with T2DM have been referred to local eye screening services on diagnosis. Annual diabetic retinopathy screening from the age of 12 years is recommended. This should be performed as soon as possible (i.e. no later than 3 months after referral date or 12th birthday if referred before age 12).

Consider referring CYP with T2DM who are younger than 12 years to an ophthalmologist for retinal examination if BG control is suboptimal.

Diabetes Neuropathy:

Diabetes Peripheral Neuropathy (DPN):

There can be three times higher prevalence of DPN among CYP with T2DM (22%) compared with those with T1DM (7%), and could be attributed to their older age, although metabolic syndrome and a longer prediabetes phase among CYP with T2DM could also have played a significant role in the development of DPN. ²

The Diabetes Control and Complications Trial (DCCT) and UK Prospective Diabetes Study (UKPDS) have both reported that good glycaemic control could potentially delay the development and progression of DPN and other microvascular complications in individuals with T1DM and T2DM. ¹

Diabetic Autonomic Neuropathy (DAN):

Clinical symptoms of autonomic neuropathy appear long after diagnosis of diabetes but are associated with high incidence diabetes complications. Maintaining near normal BG levels in early childhood may delay the development of clinically significant nerve impairment.

Feet examination:

CYP with T2DM who are under 12 years and their family members or carers (as appropriate) should be provided with basic foot care advice.

- For those who are 12 to 17 years, the diabetes health care providers should assess the young person's feet as part of their annual assessment.

This screening examination should include inspection, palpation of the pulses, testing the 8 point sensation using the monofilament, position and vibration testing using 128 Hz tuning fork and provide information about foot care.

- If a diabetic foot problem is found or suspected, the young person should be referred to Podiatrist or to an appropriate specialist.

Polycystic Ovarian Syndrome (PCOS):²⁴

Polycystic ovary syndrome (PCOS) can be associated with adolescent girls with T2DM. PCOS can increase the risk for endometrial cancer and cardiovascular complications.

Menstrual history should be taken on every pubertal age girl with T2DM at diagnosis and at each visit. If there is primary or secondary amenorrhea, hirsutism and or significant acne, an evaluation for PCOS should be considered. Diagnosis of PCOS is based on the presence of oligo or amenorrhea, reversed LH/FSH ratio with biochemical or clinical evidence of hyperandrogenism, with or without evidence for polycystic ovaries on USS. Weight loss, exercise and Metformin can decrease insulin resistance and improve ovarian function and fertility. Consider referring to appropriate specialist team after confirming diagnosis.

Obstructive Sleep Apnoea (OSA):

OSA is common in obese CYP. Poor sleep quality and daytime sleepiness, increased risk for hypertension, left ventricular hypertrophy and increased risk of renal and cardiovascular disease are recognised with OSA.

CYP with T2DM should be screened for OSA using questions about snoring, sleep quality, apnoea, morning headaches, daytime sleepiness, nocturia, and enuresis. If symptoms are suggestive of OSA, refer to a respiratory paediatrician who can arrange a sleep study to confirm the diagnosis.

Atherosclerosis and Vascular dysfunction:

CYP with T2DM have increased risk for endothelial dysfunction, increased intima media thickness, serum markers of endothelial damage, left ventricular hypertrophy, reduced exercise capacity and increased arterial stiffness, all of which predict early cardiovascular morbidity and mortality.

Weight reduction is helpful to avoid these risks.

6.9 Immunisation: ^{29, 16}

Recommend annual immunisation against influenza and pneumococcal infection for children and young people with diabetes who need insulin or oral hypoglycaemic medicines. ¹⁶

6.10 Dental examination:

Regular dental check-ups should be encouraged because of the risk of tooth decay and gum disease especially in poorly controlled patients.

6.11 Additional health problems related to obesity and T2DM, which need to be considered, are:

- Orthopaedic problems resulting in diminishing physical activity.
- Pancreatitis.
- Cholecystitis.
- Idiopathic intracranial hypertension.
- Deep tissue ulcers.

7. Surgery for CYP with T2DM:

Surgery in CYP with T2DM should only be performed in centres that have dedicated paediatric facilities for caring CYP with diabetes. All these centres should have written protocols on safe surgery for CYP. These protocols should have been agreed between surgical and anaesthetic staff and the diabetes team.

8. Other therapies and research update:

Current treatment options for CYP with T2DM are limited to **two approved drugs – insulin and metformin** ⁸

There are **other drugs**, which are not approved for use in < 18 years of age, either because of lack of paediatric clinical trials or because of their adverse effects. **These are listed below** ^{19, 22}

- **Sulfonylureas (Glipizide, Glyburide, Glimepiride, etc.):** Stimulate the release of insulin from the β -cells of pancreas. The major adverse effects of sulfonylureas are severe and prolonged hypoglycaemia and weight gain. A paediatric clinical trial of a sulfonylurea (glimepiride) showed no superior efficacy to Metformin and a greater degree of weight gain and hypoglycaemia. There are concerns that treatment with sulfonylureas may actually hasten the beta cell decline in young onset T2DM.
- **Meglitinides (Repaglinide, Nateglinide):** Stimulate the release of insulin from the β -cells of pancreas in glucose dependent manner. Their most common adverse events include hypoglycaemia, upper respiratory tract infection, diarrhoea and headaches. Data regarding use in children are limited to a few case reports.

- **Thiazolidinediones - TZD's- (Pioglitazone, Rosiglitazone):** TZDs work to decrease BG by increasing insulin sensitivity in target organs like liver, muscle and adipose tissue and to decrease hepatic glucose synthesis. TZDs have been associated with potential increased risk of bladder cancer and fracture rates. Pioglitazone has not been studied in children. Rosiglitazone has been observed to increase cardiovascular ischaemic risk in adults.
- A more recent study trial (**TODAY Study** ⁴¹) examined the durability of metformin in 699 patients 10 to 17 years of age with T2DM. After a 2 to 6 month run-in period of metformin monotherapy, patients were randomised to metformin alone, to metformin plus rosiglitazone or to metformin plus lifestyle interventions. This study concluded that the glycaemic durability of metformin plus rosiglitazone was superior to therapy with metformin alone in children with T2DM, despite a small increase in BMI.
- **GLP-1 Agonists (Exenatide, Liraglutide):** Both Exenatide and Liraglutide work as a glucagon-like-peptide-1 (GLP-1) agonists. GLP-1 is an incretin hormone released from the gut in response to meals. Its beneficial effects include slowed gastric emptying, enhanced insulin synthesis, improved β -cell function and decreased appetite. The most common adverse events associated with GLP-1 agonists are nausea, hypoglycaemia, vomiting, headache and diarrhoea. Exenatide should be avoided with in patients with a history of pancreatitis and severe renal impairment or end-stage-renal-disease. Liraglutide should be avoided in patients with a history of pancreatitis and personal or family history of medullary thyroid carcinoma.
- Liraglutide was well tolerated in CYP with T2DM, with safety, tolerability, and pharmacokinetic profiles similar to profiles in adults during a small (n=19) randomized, double-blind, placebo-controlled trial. ¹¹ No serious adverse events (AEs), including severe hypoglycaemia, occurred.
- **Ellipse** ^{TM,4} is another randomized, double-blind, placebo-controlled trial which is looking into the efficacy and safety of Liraglutide in combination with Metformin compared to Metformin alone in CYP with T2DM.
- **DPP-4 Inhibitors (Saxagliptin, Sitagliptin, Alogliptin, and Linagliptin):** These inhibit the dipeptidyl-peptidase-4 (DPP-4) enzyme, which rapidly break down GLP-1 so that the beneficial effects of GLP-1 remain active. The most common adverse events associated with DPP-4 inhibitors include upper respiratory tract infection, urinary tract infection, headache and nasopharyngitis. A study of combination therapy with DPP4-inhibitor and Metformin completed in 2018 and is due to report in 2019.
- **Alpha-Glucosidase Inhibitors (Acarbose, Miglitol):** These inhibit the breakdown of complex sugars and delay absorption of glucose from intestinal border. Common adverse events include flatulence, diarrhoea and abdominal cramps and are unlikely to be well accepted by the paediatric population. The alpha-glucosidase inhibitors have not been well studied in paediatric population.
- **Amylin analog (Pramlintide):** Inhibits glucagon secretion, delays gastric emptying and improves satiety. The most common adverse events associated with pramlintide include hypoglycaemia, nausea, headache, anorexia and abdominal pain. Clinical evidence regarding the use of pramlintide in CYP is limited to T1DM.
- **Sodium-glucose co-transporter 2 (SGLT2) inhibitors:** SGLT2 inhibitors are FDA and MHRA-approved for use with diet and exercise to lower blood sugar in adults with type 2 diabetes. They reversibly

inhibit sodium-glucose co-transporter 2 (SGLT2) in the renal proximal convoluted tubule to reduce glucose reabsorption and increase urinary glucose excretion.

- Medicines in the SGLT2 inhibitor class include canagliflozin, dapagliflozin, and empagliflozin. They are available as single-ingredient products and also in combination with other diabetes medicines such as metformin. A review by the European Medicines Agency has concluded that serious, life-threatening, and fatal cases of diabetic ketoacidosis (DKA) have been reported rarely in patients taking an SGLT2 inhibitor.

Bariatric surgery:

Small retrospective analyses and a recent prospective multicentre nonrandomised study suggest that bariatric surgery may have similar degrees of weight loss, diabetes remission and improvement of cardio metabolic risk factors for at least 3 years after surgery in obese adolescents with T2DM compared with those observed in adults. However, there are no randomised trials comparing the effectiveness and safety of surgery to those of conventional treatment options in CYP.⁸

Currently bariatric surgery is considered for adolescents with T2DM and BMI > 35 kg / m² who have uncontrolled hyperglycaemia and/or comorbidities despite lifestyle and pharmacologic treatment. This treatment should be undertaken only in centres of excellence.

Current research studies:

There are always on-going research studies, for information please contact the BSPED Website <https://www.bsped.org.uk/>

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10. Appendices:

Appendix 1. BMI centile charts:

GIRLS UK Body mass index (BMI) 2-20 years

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The BMI centile is a simple and reliable indicator of thinness and fatness in childhood. Where severe over- or underweight is a concern, or where there is a need for monitoring over time, BMI can be calculated and plotted on this chart. It is important also to plot the height and weight separately on the main 2-18 chart. There is also a BMI centile look-up on the standard 2-18 chart for less complex cases.

BMI is calculated by dividing weight (in kg) by the square of height (in metres e.g. 1.32 m, not centimetres e.g. 132 cm).

A simple way to do this on a calculator or mobile phone is:

1. Enter the weight. 2. Divide by height. 3. Divide the result by height. The result can then be plotted on the chart below.

Please place sticker (if available) otherwise write in space provided.

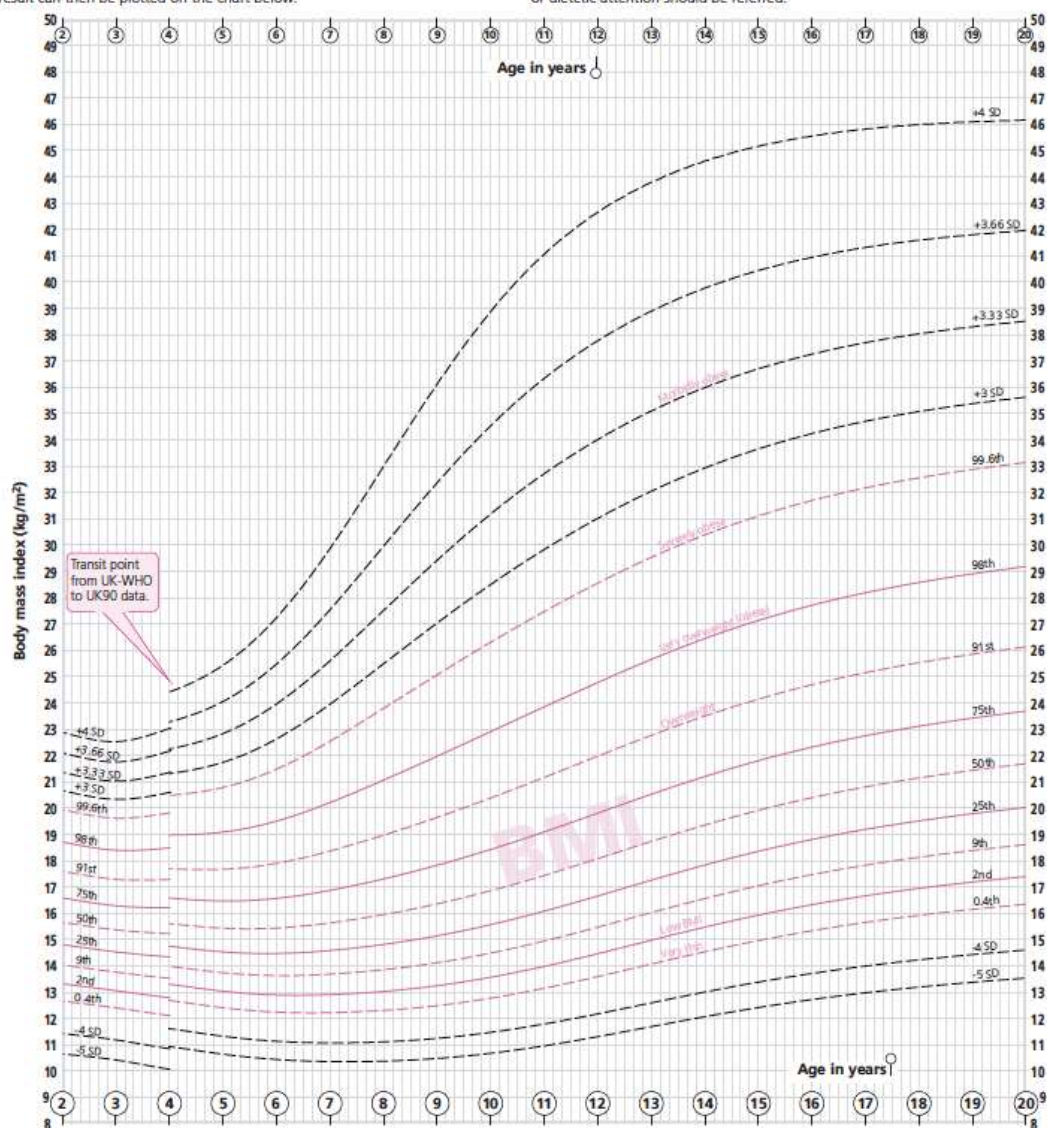
Name: _____
NHS/CHI No: _____
Hospital No: _____
Date of Birth: ____/____/____

Overweight and obesity

A BMI above the 91st centile suggests overweight. A child above the 98th centile is very overweight (clinically obese) while a BMI above the 99.6th centile is severely obese. In addition to the usual nine centile lines, the BMI chart displays high lines at +3, +3.33, +3.66 and +4 SD, which can be used to monitor the progress of children in overweight treatment programmes.

Thinness

A BMI below the 2nd centile is unusual and may reflect undernutrition, but may simply reflect a small build. The chart also displays low lines at -4 and -5 SD for those who are severely underweight. Children whose BMI lies below the 0.4th centile are likely to have additional problems and if not already receiving medical or dietetic attention should be referred.



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Data Recording

Measurement 1	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 2	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 3	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 4	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 5	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 6	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 7	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 8	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 9	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Measurement 10	
Recording Date	
Weight	
Length/Height	
BMI	
Location	
Health worker name	

Data Recording

Measurement 1

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 2

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 3

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 4

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 5

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 6

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 7

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 8

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 9

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

Measurement 10

Recording Date
Weight
Length/Height
BMI
Location
Health worker name

BOYS UK

Body mass index (BMI)

2-20 years

RCPCH (DH) Department of Health
Royal College of Paediatrics and Child Health
Leading the way in Children's Health

The BMI centile is a simple and reliable indicator of thinness and fatness in childhood. Where severe over- or underweight is a concern, or where there is a need for monitoring over time, BMI can be calculated and plotted on this chart. It is important also to plot the height and weight separately on the main 2-18 chart. There is also a BMI centile look-up on the standard 2-18 chart for less complex cases.

BMI is calculated by dividing weight (in kg) by the square of height (in metres e.g. 1.32 m, not centimetres e.g. 132 cm).

A simple way to do this on a calculator or mobile phone is:

1. Enter the weight. 2. Divide by height. 3. Divide the result by height.

The result can then be plotted on the chart below.

Please place sticker (if available) otherwise write in space provided.

Name: _____

NHS/CHI No: _____

Hospital No: _____

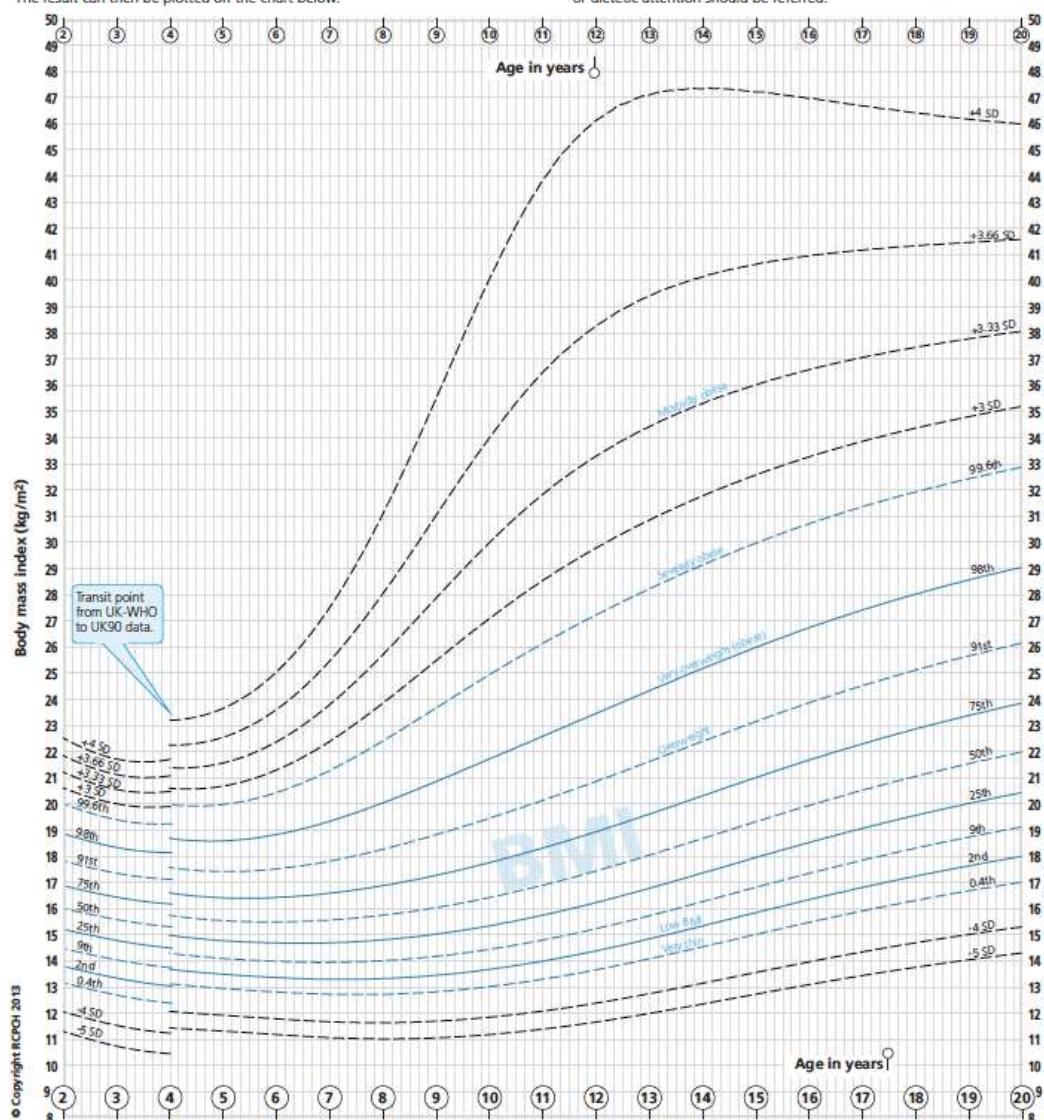
Date of Birth: ____/____/____

Overweight and obesity

A BMI above the 91st centile suggests overweight. A child above the 98th centile is very overweight (clinically obese) while a BMI above the 99.6th centile is severely obese. In addition to the usual nine centile lines, the BMI chart displays high lines at +3, +3.33, +3.66 and +4 SD, which can be used to monitor the progress of children in overweight treatment programmes.

Thinness

A BMI below the 2nd centile is unusual and may reflect undernutrition, but may simply reflect a small build. The chart also displays low lines at -4 and -5 SD for those who are severely underweight. Children whose BMI lies below the 0.4th centile are likely to have additional problems and if not already receiving medical or dietetic attention should be referred.



Manufacture 1 May 13

Appendix 2. Blood pressure centiles, Age 1- 17 years:

Blood Pressure Levels for Boys by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	80	81	83	85	87	88	89	34	35	36	37	38	39	39
	90th	94	95	97	99	100	102	103	49	50	51	52	53	53	54
	95th	98	99	101	103	104	106	106	54	54	55	56	57	58	58
	99th	105	106	108	110	112	113	114	61	62	63	64	65	66	66
2	50th	84	85	87	88	90	92	92	39	40	41	42	43	44	44
	90th	97	99	100	102	104	105	106	54	55	56	57	58	58	59
	95th	101	102	104	106	108	109	110	59	59	60	61	62	63	63
	99th	109	110	111	113	115	117	117	66	67	68	69	70	71	71
3	50th	86	87	89	91	93	94	95	44	44	45	46	47	48	48
	90th	100	101	103	105	107	108	109	59	59	60	61	62	63	63
	95th	104	105	107	109	110	112	113	63	63	64	65	66	67	67
	99th	111	112	114	116	118	119	120	71	71	72	73	74	75	75
4	50th	88	89	91	93	95	96	97	47	48	49	50	51	51	52
	90th	102	103	105	107	109	110	111	62	63	64	65	66	66	67
	95th	106	107	109	111	112	114	115	66	67	68	69	70	71	71
	99th	113	114	116	118	120	121	122	74	75	76	77	78	78	79
5	50th	90	91	93	95	96	98	98	50	51	52	53	54	55	55
	90th	104	105	106	108	110	111	112	65	66	67	68	69	69	70
	95th	108	109	110	112	114	115	116	69	70	71	72	73	74	74
	99th	115	116	118	120	121	123	123	77	78	79	80	81	81	82
6	50th	91	92	94	96	98	99	100	53	53	54	55	56	57	57
	90th	105	106	108	110	111	113	113	68	68	69	70	71	72	72
	95th	109	110	112	114	115	117	117	72	72	73	74	75	76	76
	99th	116	117	119	121	123	124	125	80	80	81	82	83	84	84
7	50th	92	94	95	97	99	100	101	55	55	56	57	58	59	59
	90th	106	107	109	111	113	114	115	70	70	71	72	73	74	74
	95th	110	111	113	115	117	118	119	74	74	75	76	77	78	78
	99th	117	118	120	122	124	125	126	82	82	83	84	85	86	86
8	50th	94	95	97	99	100	102	102	56	57	58	59	60	60	61
	90th	107	109	110	112	114	115	116	71	72	72	73	74	75	76
	95th	111	112	114	116	118	119	120	75	76	77	78	79	79	80
	99th	119	120	122	123	125	127	127	83	84	85	86	87	87	88
9	50th	95	96	98	100	102	103	104	57	58	59	60	61	61	62
	90th	109	110	112	114	115	117	118	72	73	74	75	76	76	77
	95th	113	114	116	118	119	121	121	76	77	78	79	80	81	81
	99th	120	121	123	125	127	128	129	84	85	86	87	88	88	89
10	50th	97	98	100	102	103	105	106	58	59	60	61	61	62	63
	90th	111	112	114	115	117	119	119	73	73	74	75	76	77	78
	95th	115	116	117	119	121	122	123	77	78	79	80	81	81	82
	99th	122	123	125	127	128	130	130	85	86	86	88	88	89	90

Blood Pressure Levels for Boys by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	99	100	102	104	105	107	107	59	59	60	61	62	63	63
	90th	113	114	115	117	119	120	121	74	74	75	76	77	78	78
	95th	117	118	119	121	123	124	125	78	78	79	80	81	82	82
	99th	124	125	127	129	130	132	132	86	86	87	88	89	90	90
12	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91
13	50th	104	105	106	108	110	111	112	60	60	61	62	63	64	64
	90th	117	118	120	122	124	125	126	75	75	76	77	78	79	79
	95th	121	122	124	126	128	129	130	79	79	80	81	82	83	83
	99th	128	130	131	133	135	136	137	87	87	88	89	90	91	91
14	50th	106	107	109	111	113	114	115	60	61	62	63	64	65	65
	90th	120	121	123	125	126	128	128	75	76	77	78	79	79	80
	95th	124	125	127	128	130	132	132	80	80	81	82	83	84	84
	99th	131	132	134	136	138	139	140	87	88	89	90	91	92	92
15	50th	109	110	112	113	115	117	117	61	62	63	64	65	66	66
	90th	122	124	125	127	129	130	131	76	77	78	79	80	80	81
	95th	126	127	129	131	133	134	135	81	81	82	83	84	85	85
	99th	134	135	136	138	140	142	142	88	89	90	91	92	93	93
16	50th	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	90th	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95th	129	130	132	134	135	137	137	82	83	83	84	85	86	87
	99th	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	50th	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	90th	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95th	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99th	139	140	141	143	145	146	147	92	93	93	94	95	96	97

BP, blood pressure

* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

For research purposes, the standard deviations in Appendix Table B-1 allow one to compute BP Z-scores and percentiles for boys with height percentiles given in Table 3 (i.e., the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height Z-scores given by (5% = -1.645; 10% = -1.28; 25% = -0.68; 50% = 0; 75% = 0.68; 90% = 1.28; 95% = 1.645) and then computed according to the methodology in steps 2-4 described in Appendix B. For children with height percentiles other than these, follow steps 1-4 as described in Appendix B.

Blood Pressure Levels for Girls by Age and Height Percentile

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	50th	83	84	85	86	88	89	90	38	39	39	40	41	41	42
	90th	97	97	98	100	101	102	103	52	53	53	54	55	55	56
	95th	100	101	102	104	105	106	107	56	57	57	58	59	59	60
	99th	108	108	109	111	112	113	114	64	64	65	65	66	67	67
2	50th	85	85	87	88	89	91	91	43	44	44	45	46	46	47
	90th	98	99	100	101	103	104	105	57	58	58	59	60	61	61
	95th	102	103	104	105	107	108	109	61	62	62	63	64	65	65
	99th	109	110	111	112	114	115	116	69	69	70	70	71	72	72
3	50th	86	87	88	89	91	92	93	47	48	48	49	50	50	51
	90th	100	100	102	103	104	106	106	61	62	62	63	64	64	65
	95th	104	104	105	107	108	109	110	65	66	66	67	68	68	69
	99th	111	111	113	114	115	116	117	73	73	74	74	75	76	76
4	50th	88	88	90	91	92	94	94	50	50	51	52	52	53	54
	90th	101	102	103	104	106	107	108	64	64	65	66	67	67	68
	95th	105	106	107	108	110	111	112	68	68	69	70	71	71	72
	99th	112	113	114	115	117	118	119	76	76	76	77	78	79	79
5	50th	89	90	91	93	94	95	96	52	53	53	54	55	55	56
	90th	103	103	105	106	107	109	109	66	67	67	68	69	69	70
	95th	107	107	108	110	111	112	113	70	71	71	72	73	73	74
	99th	114	114	116	117	118	120	120	78	78	79	79	80	81	81
6	50th	91	92	93	94	96	97	98	54	54	55	56	56	57	58
	90th	104	105	106	108	109	110	111	68	68	69	70	70	71	72
	95th	108	109	110	111	113	114	115	72	72	73	74	74	75	76
	99th	115	116	117	119	120	121	122	80	80	80	81	82	83	83
7	50th	93	93	95	96	97	99	99	55	56	56	57	58	58	59
	90th	106	107	108	109	111	112	113	69	70	70	71	72	72	73
	95th	110	111	112	113	115	116	116	73	74	74	75	76	76	77
	99th	117	118	119	120	122	123	124	81	81	82	82	83	84	84
8	50th	95	95	96	98	99	100	101	57	57	57	58	59	60	60
	90th	108	109	110	111	113	114	114	71	71	71	72	73	74	74
	95th	112	112	114	115	116	118	118	75	75	75	76	77	78	78
	99th	119	120	121	122	123	125	125	82	82	83	83	84	85	86
9	50th	96	97	98	100	101	102	103	58	58	58	59	60	61	61
	90th	110	110	112	113	114	116	116	72	72	72	73	74	75	75
	95th	114	114	115	117	118	119	120	76	76	76	77	78	79	79
	99th	121	121	123	124	125	127	127	83	83	84	84	85	86	87
10	50th	98	99	100	102	103	104	105	59	59	59	60	61	62	62
	90th	112	112	114	115	116	118	118	73	73	73	74	75	76	76
	95th	116	116	117	119	120	121	122	77	77	77	78	79	80	80
	99th	123	123	125	126	127	129	129	84	84	85	86	86	87	88

Blood Pressure Levels for Girls by Age and Height Percentile (Continued)

Age (Year)	BP Percentile ↓	Systolic BP (mmHg)							Diastolic BP (mmHg)						
		← Percentile of Height →							← Percentile of Height →						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
11	50th	100	101	102	103	105	106	107	60	60	60	61	62	63	63
	90th	114	114	116	117	118	119	120	74	74	74	75	76	77	77
	95th	118	118	119	121	122	123	124	78	78	78	79	80	81	81
	99th	125	125	126	128	129	130	131	85	85	86	87	87	88	89
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90
13	50th	104	105	106	107	109	110	110	62	62	62	63	64	65	65
	90th	117	118	119	121	122	123	124	76	76	76	77	78	79	79
	95th	121	122	123	124	126	127	128	80	80	80	81	82	83	83
	99th	128	129	130	132	133	134	135	87	87	88	89	89	90	91
14	50th	106	106	107	109	110	111	112	63	63	63	64	65	66	66
	90th	119	120	121	122	124	125	125	77	77	77	78	79	80	80
	95th	123	123	125	126	127	129	129	81	81	81	82	83	84	84
	99th	130	131	132	133	135	136	136	88	88	89	90	90	91	92
15	50th	107	108	109	110	111	113	113	64	64	64	65	66	67	67
	90th	120	121	122	123	125	126	127	78	78	78	79	80	81	81
	95th	124	125	126	127	129	130	131	82	82	82	83	84	85	85
	99th	131	132	133	134	136	137	138	89	89	90	91	91	92	93
16	50th	108	108	110	111	112	114	114	64	64	65	66	66	67	68
	90th	121	122	123	124	126	127	128	78	78	79	80	81	81	82
	95th	125	126	127	128	130	131	132	82	82	83	84	85	85	86
	99th	132	133	134	135	137	138	139	90	90	90	91	92	93	93
17	50th	108	109	110	111	113	114	115	64	65	65	66	67	67	68
	90th	122	122	123	125	126	127	128	78	79	79	80	81	81	82
	95th	125	126	127	129	130	131	132	82	83	83	84	85	85	86
	99th	133	133	134	136	137	138	139	90	90	91	91	92	93	93

BP, blood pressure

* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

For research purposes, the standard deviations in Appendix Table B-1 allow one to compute BP Z-scores and percentiles for girls with height percentiles given in Table 4 (i.e., the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height Z-scores given by (5% = -1.645; 10% = -1.28; 25% = -0.68; 50% = 0; 75% = 0.68; 90% = 1.28; 95% = 1.645) and then computed according to the methodology in steps 2-4 described in Appendix B. For children with height percentiles other than these, follow steps 1-4 as described in Appendix B.

Appendix 3: Recommendations on methods of achieving goals:

Weight management:

a) Weight management

Assessment/capturing data

Biometrics:

Measure height, weight and BMI at each appointment and discuss with families why we do this and check their understandings of the risks of carrying excess weight. Care should be taken to approach the subject of weight in a sensitive way and if possible all families should see a psychologist soon after diagnosis to discuss attitudes towards eating and their relationship with food.

Food diaries:

Diaries can be a useful tool for some families to assess the diet and determine which areas to focus on to improve diet quality. They can also be used to capture emotions felt when eating. If families find this invasive or shaming, alternative approaches will be more helpful in building a good relationship with the family. It is important to establish what families know about healthy eating already before starting dietary education. Talking about healthy change more generally and asking families to make suggestions for change are often more helpful than focusing only on the individual's current situation. Discussions around barriers to change - such as the cost of eating healthily, others in the family not needing to lose weight etc – is important in making progress with change.

Reducing sugar:

Advise on cutting out all sugary drinks and sugary sweets completely – replace sugary drinks, including fruit juice with water ideally and no added sugar drinks if necessary, to maintain hydration. Sugar free sweets are not recommended due to the laxative effect of those made with polyols (sugar alcohols).

Which diet?

- Discuss different methods of achieving an energy deficit of around 300-500kcal compared with energy requirements.
- Different approaches include a reduced carbohydrate intake to around 26-45% and reduced portion sizes of protein and fat. An increase in fibre intake is usually required. Recommendations are age dependent and are as follows: 20g/day (age 5-11); 25g/day (age 11-16); 30g/day (age 16-18) ³⁷.
- A decrease in saturated fat may be beneficial in reducing insulin resistance as well as from a heart health perspective.
- Offer a variety of methods to achieve an energy deficit and explore any ideas the family has. Attending slimming groups or clubs may be very useful for more support for some families and most offer programmes for young people. There are also a number of on-line support options available if families are willing to consider these. There are costs associated with these additional support methods.
- The diet should include a wide range of micronutrients and supplementation may need to be considered if variety in the diet is very limited.

Portion size:

Look at current portion sizes and advise on the commonly used weight loss plate structure – half plate veg/salad, quarter carbs and quarter protein. Plan and adjust favourite meals to fit with this model. Resources on portion sizes and food groups on the Change4Life website may be useful to guide families. The British Heart Foundation also offer guidance on portion sizes and the number of portions for daily balance.

Cooking:

- Encourage cooking meals from scratch with less reliance on processed food and takeaway foods in order to reduce salt intake (as previously discussed). Look at recipes for cooking favourite foods to reduce fat and sugar content, reducing energy provision from these.

Nutritional information/label reading:

- Explain how to read nutrition information on labels so that families understand portion size and comparison of nutrients in foods per 100g of food and how to choose lower energy (kcal) options.
- **Meal planning** – providing families with a simple layout for a meal plan with the days of the week and meal times + snacks allows them to plan and shop more efficiently. The benefits of this in terms of saving money and not having tempting foods at home that may take the family off track.
- **Glycaemic Index (GI)** - detailed education on the GI of carbohydrates should be included in the lifestyle programme with particular emphasis on satiety. This may be of greater importance for breakfast and snacks that are carbohydrate rich where the type of carbohydrate has a greater impact on blood glucose excursion.

Blood glucose control:

Individualised approach is really important for maximizing time in blood glucose targets. There is a large variation in the way in which different foods affect the blood glucose levels of the individual.⁴²

D Diaries that look at both BG levels and food eaten are important to establish which foods to minimise.

- Look at BG readings in conjunction with other information recorded on food intake to identify particular meals or foods that cause larger BG excursions than others.
- Look at the impact of snacks and decide whether these are better included or excluded. Do this also by reviewing total energy (kcal) in the diet and make sure that meal sizes are smaller if snacks are included, should young people find this a better method of appetite control and/or BG management.
- Detailed education on glycaemic index of carbohydrates should be included in the lifestyle programme with particular emphasis on satiety. This may be of greater importance for breakfast and snacks that are carbohydrate rich where the type of carbohydrate has a greater impact on BG excursion. In light of the effect of higher levels of certain hormones in the body at early morning time, the type of breakfast may have an effect on being able to minimise BG excursions, reducing average BG levels achievable.

Behaviour change:

- Request food, exercise, mood and BG recording.
- Discuss availability of foods at home – unhealthy snacks in the cupboards and advise against these being bought/stored at home – a family approach to healthy eating is advised.
- Discuss how pocket money is used and talk about saving for items other than food rather than spending on snacks and takeaways.
- Include education of staff at school to encourage healthy eating and/or to supervise insulin as appropriate/if necessary.
- Evidence based psychological interventions including motivational interviewing, solution focused therapy, Mindfulness Eating and CBT.
- Set SMART goals after each session (specific, measurable, realistic and time orientated) that are agreed with the family.

Appendix 4: Nutrients – additional information:

Vitamin D:

In the UK, children over the age of 4 years should be taking vitamin D supplement of 10 µg/d (400 IU/d), throughout the year.^{8, 27}

Information on dietary sources is available in the British Dietetic Association information sheet¹¹.

Vitamin B12:

Good dietary sources of vitamin B12 include eggs, dairy, meat, fish and shellfish as well as fortified cereals¹¹.

It is worth checking on nutritional sources of vitamin B12, especially in vegans who are likely to have a low intake due to avoidance of meat and dairy. Daily requirements are 1.5micrograms/day.

Magnesium:

Dietary sources of magnesium include: wholegrains, green leafy vegetables, nuts and beans. These are all foods that would naturally be encouraged as part of any healthy, weight loss programme. Supplementation should not normally be required. Requirements for magnesium are 11.5 -12.3 mmol/day for boys and girls aged 11-18 years.

(All above recommendations - Dietary Reference Values 1991).

Appendix 5: Exercise

Activity:

Household tasks:

Examples of household tasks and how many calories are burned. It may be useful to show this to parents as a way of encouraging increased day to day activity.

Chores- 30 minutes	Calories
Washing a car	143kcal
Carrying shopping bags	190kcal
Cleaning windows	125kcal
Vacuuming	90kcal
Ironing	70kcal

Reducing screen time:

Brief periods of exercise as part of screen time can be helpful. For example; walking/jumping/jogging on spot whilst a game loads/during adverts. Promote the use of exercise equipment in the home such as trampoline, wii-fit, exercise bike.

A practical approach to planning the initiation of exercise in sedentary children and adolescents with type 1 diabetes (Adapted for T2DM from ISPAD – Chapter 14. TABLE 4)

For all CYP with T2DM:

- Identify barriers that might reduce chances of success (e.g., fear of hypoglycaemia, knowledge gaps, parental barriers, personal fears of embarrassment, body image concerns)
- Set a specific goal (e.g., improved fitness, better glucose control, weight loss, safety vs performance)
- Plan the schedule of exercise where possible (e.g., every day, 3 days per week)
- Discuss the type of exercise and how this affects glucose levels

For those CYP with T2DM on insulin:

All of the above are applicable but for those young people on **insulin**, more detailed advice needs to be given on adjusting insulin amounts at meal times prior and post exercise. Recommendations should follow the guidance given to those adolescents with type 1 diabetes.

These can be summarised below:

- Discuss time of day, especially if exercise will be close to meals or in the evening
- Discuss a specific glucose monitoring plan (to check glucose before, during and after exercise)
- Plan pre-exercise meal and insulin dose (timing and any dose adjustment)
- Plan basal injected insulin dose adjustment, or pump basal rate adjustment so that it is active during the desired period
- Plan the post-exercise meal and insulin dose (timing and any dose adjustment)
- Discuss risks of delayed glycaemic excursions and plan to avoid post-exercise nocturnal hypoglycaemia
- Plan the time to review glucose data around exercise with care team such that modifications can be made

Plan review of overall insulin doses after 1-2 weeks as insulin sensitivity changes (note—3 months later at the next clinic visit is not soon enough).