

Adolescent-onset metabolic syndrome

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Natalie is a fourth year medical student at Monash University with a particular interest in women's and children's health. She has spent some time researching which enabled her to realise that she would rather be on the ward than in the lab.

Obesity is a common cause of insulin resistance (metabolic syndrome) in adults, however in recent years this has extended into much younger age groups. Associated conditions including dyslipidaemia, type 2 diabetes mellitus, and cardiovascular complications are all major components of metabolic syndrome. This case report describes a sixteen-year-old with features typical of adult-onset metabolic syndrome. The patient described in this report did not receive adequate treatment for three years after her initial diagnosis, which highlights challenges in engaging with and managing this age group. This report discusses the use of a biopsychosocial approach in managing metabolic syndrome in the adolescent population.

Case

DT is a sixteen-year-old female who was referred to the emergency department by her general practitioner (GP) after she was found to have a blood glucose level of 14.1mmol/L. She was commenced on intravenous saline and short-acting insulin, and transferred to the paediatric ward.

DT had been diagnosed with a cluster of health problems collectively known as the metabolic syndrome at 13 years of age, but subsequently ceased prescribed medication and failed to attend follow-up appointments. Her co-morbidities at the time included type 2 diabetes mellitus (T2DM), dyslipidaemia, obesity, and non-alcoholic fatty liver disease. She was also found to have obstructive sleep apnoea and polycystic ovarian syndrome.

She reported that most of her adult relatives were overweight, however denied any family history of T2DM or any hereditary conditions. She had never smoked, or participated in alcohol or recreational drug use.

Having emigrated from Samoa at age 11, DT said she had few friends, although she socialised within her church community. DT dealt with domestic violence in her immediate family, parental separation, and was responsible for the care of her seven siblings.

On examination, DT was severely obese with a body mass index (BMI) of 41.8kg/m². Her vital signs were all within the normal ranges and she had no signs of diabetic ketoacidosis. Of significance was the presence of acanthosis nigricans on her neck, elbow creases, and axillae, indicating longstanding insulin resistance. She had a deep voice, but no other signs of hyperandrogenism.

DT's investigations revealed a HbA1c of 12.2% (reference range [RR]<6.5%), fasting glucose level of 14.1mmol/L (RR: 4.0-6.0), alanine transaminase of 56 mmol/L (RR <30), aspartate amino transferase of 44mmol/L (RR <30), and gamma-glutamyl transferase of 64 mmol/L (RR <30). Ketones, fasting lipid profile, and thyroid function tests were all within the normal ranges, and no insulin autoantibodies were present. Urinalysis demonstrated glycosuria but not ketonuria.

These results confirmed the previous diagnosis of T2DM. However, due to the resolution of dyslipidaemia and her normal blood pressure, DT no longer met the International Diabetes Federation criteria for metabolic syndrome. The deranged liver function tests were consistent with her previous diagnosis of non-alcoholic fatty liver disease.

DT was managed in a multidisciplinary setting involving a paediatrician, endocrinologist, diabetes educator, dietitian, and a social worker. She received ongoing care from a local GP and the paediatric endocrinology



hospital outpatient service. The GP initially checked her blood glucose level weekly and adjusted the metformin dosage (1 x 850mg mane, 2 x 850mg nocte) [1] as required. The allied health team provided her with a lifestyle plan to reduce her dietary energy intake, to include incidental exercise as part of a regular exercise regimen, and distraction strategies to address overeating. DT was also booked for appointments to monitor diabetes-related complications (ophthalmology, renal, and podiatry clinics). Due to difficulty locating an appropriate interpreter, DT's mother was not actively involved in discussions regarding her ongoing management. This made it incredibly difficult for the treating team to include DT's family in the management plan, despite family involvement being a crucial component of care of the adolescent.

DT was involved in many discussions around her extensive management plan, however she asked upon discharge, "What if I can't?" Her self-doubt demonstrates a normal, adolescent response to an overwhelming challenge and is worsened by a lack of family involvement in her care. It remains uncertain as to whether DT will attend any follow-up appointments.

Discussion

Adolescent obesity

With obesity rates in Australians being very high, the public eye has long been focused on the health impacts of the modern lifestyle. The 2007 Australian National Children's Nutrition and Physical Activity Survey found that 17% of Australian children were overweight and 6% were obese. [2] Despite these figures, only a minority of Australian GPs routinely perform measurements such as height, weight, and calculation of body mass index in children, relying on visual inspection alone to assess weight. In addition, many GPs find it difficult to raise the issue of weight management with children and their families, resulting in delayed or lack of dietary control and lifestyle modification. [3]

Adolescence is a time when the ability to learn increases and new habits are adopted yet the ability to self-regulate is not fully developed. [4] Overweight adolescents may desire the improved body image and self-esteem that weight loss might entail but lack an understanding of the practical steps that need to be undertaken in order to achieve that goal. [5]

The Metabolic Syndrome in the Paediatric Population

The metabolic syndrome is a term used to describe the co-occurrence of a range of metabolic risk factors including abdominal obesity,

Age (years)	Obesity	Triglycerides	HDL-C	Blood pressure	Glucose
6-9	≥90th centile				
10-16	≥90th centile or adult cut-off	>1.7mmol/L	<1.03mmol/L	Systolic BP >130 or diastolic BP ≥85mmHg	BGL≥5.6mmol/L or known T2DM
>16 (adult criteria)	WC≥94cm (male) or ≥80cm (female) Or BMI >30kg/m ²	≥1.7mmol/L or treated	<1.03mmol/L (male) or <1.29mmol/L (female) or treated	Systolic BP >130 or diastolic BP ≥85mmHg or treated	BGL≥5.6mmol/L or known T2DM

Table 1. International Diabetes Federation-modified definition of metabolic syndrome in children and adolescents [8] (WC=waist circumference). HDL-C, high density lipoprotein cholesterol; BP, blood pressure; BGL, blood glucose level; T2DM, type II diabetes mellitus; WC, weight circumference; BMI, body mass index.

hyperglycaemia, dyslipidaemia, and hypertension. [6] While the overt disease is rare in the paediatric population, adult cardiovascular disease is more common in those who exhibited metabolic syndrome traits as children compared to those who did not. [7]

The International Diabetes Federation requires the presence of central obesity as well as two other metabolic abnormalities to reach a diagnosis of metabolic syndrome (Table 1). [8] While DT did not meet the full diagnostic criteria for metabolic syndrome on her current presentation she previously fulfilled these criteria and has extensive metabolic derangements consistent with this syndrome, including cardiovascular disease, non-alcoholic fatty liver disease, chronic kidney disease, and diabetic retinopathy. [6] A New Zealand study of adolescents with a Pacific Island ethnicity (including Samoan) found that although rates of overweight and obesity were high (40% and 36%), only a small proportion had aberrant glucose metabolism. This is thought to be due to better insulin secretory reserves in these populations, and thus the fact that DT has T2DM is of particular concern given that she is at an extreme end of an already at-risk population. [9] Early onset T2DM is closely associated with hereditary risk factors such as increased BMI, lower threshold for insulin resistance, and dyslipidaemia. [6] Given the established heritability of these conditions it would be suitable to test DT's immediate family members for T2DM and dyslipidaemia.

Managing metabolic risk factors

Optimal management of co-morbidities reduces both the occurrence and severity of complications. Regular monitoring should be undertaken, including assessment of blood pressure, waist circumference, fasting lipid profile, fasting blood glucose, urinalysis and renal function, HbA1c, visual acuity, and pedal sensation. [6] First line management in individuals with obesity as well as obesity-associated complications includes weight loss, as well as lifestyle interventions such as diet and exercise modification, glycaemic control, and optimisation of lipid profile. Such monitoring may present a burden on both the patient and healthcare providers but is an important secondary prevention strategy to reduce the risk of major long term complications.

The identification of risk factors for metabolic complications is crucial in adolescents for two reasons: 1) many risk factors can be modified to reduce future disease burden; [6] 2) adolescents are more likely to misjudge their weight status and thus feel either overwhelmed or unable to recognise the need to make lifestyle adjustments. [10] Clinicians play an important role in providing support and initiating lifestyle changes.

Adolescent attitudes to chronic disease management

For DT, the prospect of dietary restriction, an exercise regime, daily medication, and multiple appointments may have appeared overwhelming. The transition from childhood to adolescence is marked by heightened social awareness and often a struggle to form an individual identity. [11] A study of adolescent females found that deviation from the BMI norm is associated with greater social anxiety, depression, and lower self-worth, all of which affect not only the mental health of the individual but also their engagement with healthcare professionals. [11] In DT, these factors may also impact on

the day-to-day management of her health.

Another study investigating the experience of adolescents with T2DM, found that three main factors influence the maintenance of health and end-health outcomes: concept of illness, adjustment to diagnosis, and motivation to maintain good health. [12] The study suggests that the adolescent's beliefs about both the cause of the condition and the ability to adhere to advice are affected by motivation stemming from immediate and future consequences. If adolescents cannot yet fully understand the consequences, their motivation is sourced from family, health professionals, and their own perceptions of their health status. [10, 12] In DT's case, family dysfunction and lack of continuity of care due to emigration may have contributed to her apparent lack of motivation to comply with health recommendations.

What went wrong in DT's care?

Although several of DT's health concerns were identified when she was thirteen years old a combination of factors, including emigration and family dysfunction, meant that DT did not have adequate support. These issues might be overwhelming to an adult, and are further amplified in an adolescent who does not yet have the understanding and motivation to adhere to treatment. She may have been prevented from 'falling through the gaps' if a treating team in Australia had been established by her New Zealand doctor before she emigrated. With a comprehensive handover, DT may have been better supported by a team who at least had some information about her history. The central problem however, is the family dysfunction meaning that her parents have had very little insight into her medical issues. Also considering that she has seven siblings and her parents are estranged, her health concerns are less likely to be managed outside of the hospital environment. This complex set of issues is difficult to address and may require support from a social worker and GP. Cultural issues including language, home life, and diet may be best evaluated with a home visit by a community nurse and the assistance of an interpreter. Cultural sensitivity is imperative to establishing rapport, so input from a Pacific Islander social worker may be beneficial.

The biopsychosocial approach

When addressing chronic disease, the biopsychosocial approach is appropriate for individuals of any age. This involves consideration of the medical aspects, which for DT includes medication and specialist reviews, as well as consideration of the psychological and social factors that influence attitudes and behaviours. Traditionally, the focus has been on addressing lifestyle factors in the individual, when there are perhaps better long-term outcomes by addressing wider, societal issues. [13] Family-centred models are the current mainstay of treatment and in DT's case, will require consideration of culturally appropriate ways to engage with her family such as with social workers, interpreters, ethnic health workers, and members of her church community.

By addressing her individual concerns, which may include self-esteem and self-confidence, and by improving communication with her healthcare providers, DT may be given a better chance at improving her long-term health outcomes. As mentioned previously, by improving self-efficacy, adolescents such as DT are given the confidence in their

own ability to manage their health, and thus are more likely to be able to sustain a healthy lifestyle.

It is important to consider DT's Samoan origin, as factors such as family commitments, roles within the community, and societal expectations will influence her motivation and ability to improve her health. An investigation into the facilitators of healthy lifestyles in the Pacific Islands found that supportive role models and making physical activity more enjoyable were the most effective ways in which the health of communities could be improved. [14] These utilise the existing social structures of Pacific Island populations to provide motivation to make positive lifestyle choices and also support for long-term maintenance. Interventions should therefore focus on improving self-efficacy and providing realistic strategies. Motivational interviewing could be used by a GP to identify key goals for the individual patient to be achieved through a lifestyle plan. [4]

The increasing occurrence of typically adult-onset metabolic syndrome in children is a public health concern and DT is a prime example of the potential for patients to 'slip through the gaps'. While there are multiple public campaigns aimed at improving the modifiable risk factors in the paediatric population, the rates of obesity and

associated complications remain high. Another concern involves the many challenges unique to adolescent medicine, as the patients are not only dealing with chronic health issues but the individual changes in body and mind that are characteristic of that stage of life. This case demonstrates that a multi-faceted approach aimed at engaging, motivating, and empowering adolescents is required to optimise health outcomes in this population.

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Consent declaration

Informed consent was obtained from the patient and parent for publication of this case report

Conflict of interest

None declared.

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References

- [1] Metformin hydrochloride: Australian Government: Department of Health; 2014 [31/05/14]. Available from: <http://www.pbs.gov.au/medicine/item/1801T>.
- [2] Health TDo. 2007 Australian national children's nutrition and physical activity survey - Key findings: Australian Government; 2007 [23/09/14]. Available from: <http://www.health.gov.au/internet/main/publishing.nsf/Content/phd-nutrition-childrens-survey-keyfindings>.
- [3] Cretikos MA, Valenti L, Britt HC, Baur LA. General practice management of overweight and obesity in children and adolescents in Australia. *Med Care*. 2008;46(11):1163-9.
- [4] Fonesca H, Palmeira AL, Martins SC, Falcato L, Quaresma A. Managing paediatric obesity: a multidisciplinary intervention including peers in the therapeutic process. *BMC Pediatr*. 2014;14(89):1-8.
- [5] Hardy LL, Hills AP, Timperio A, Cliff D, Lubans D, Morgan PJ, et al. A hitchhiker's guide to assessing sedentary behaviour among young people: deciding what method to use. *J Sci Med Sport*. 2013;16:28-35.
- [6] Meigs JB. The metabolic syndrome (insulin resistance syndrome or syndrome X) [Internet]. UpToDate. 2014. Available from: <http://www.uptodate.com/contents/the-metabolic-syndrome-insulin-resistance-syndrome-or-syndrome-x>
- [7] Wake M, Clifford SA, Patton GC, Waters E, Williams J, Canterford L, et al. Morbidity patterns among the underweight, overweight and obese between 2 and 18 years: population-based cross-sectional analyses. *Int J Obes*. 2013;37:86-93.
- [8] Van Grouw JM, Volpe SL. Childhood obesity in America. *Curr Opin Endocrinol Diabetes Obes*. 2013;20(5):396-400.
- [9] Grant AM, Taungapeau FK, McAuley KA, Taylor RW, Williams SM, Waldron MA, et al. Body mass index status is effective in identifying metabolic syndrome components and insulin resistance in Pacific Island teenagers living in New Zealand. *Metabolism*. 2007;57:511-6.
- [10] Fredrickson J, Kremer P, Swinburn B, de Silva-Sanigorski A, McCabe M. Biopsychosocial correlates of weight status perception in Australian adolescents. *Body Image*. 2013;10:552-7.
- [11] Lanza HI, Echols L, Graham S. Deviating from the norm: body mass index (BMI) differences and psychosocial adjustment among early adolescent girls. *J Pediatr Psychol*. 2012;38(4):376-86.
- [12] Salamon KS, Brouwer AM, Fox MM, Olson KA, Yelich-Koth SL, Fleischman KM, et al. Experiencing type 2 diabetes mellitus: quantitative analysis of adolescents' concept of illness, adjustment and motivation to engage in self-care behaviours. *Diabetes Educ*. 2012;38:543-51.
- [13] Pratt KJ, Lamson AL, Lazorick S, Swanson MS, Cravens J, Collier DN. A biopsychosocial pilot study of overweight youth and care providers' perceptions of quality of life. *Pediatr Nurs*. 2011;26:61-8.
- [14] Siefken K, Schofield G, Schulenkorf N. Laefstael Jenses: an investigation of barriers and facilitators for healthy lifestyles of women in an urban pacific island context. *J Phys Act Health*. 2014;11:30-7.