View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by TopSCHOLAR

Physical Activity Behaviour of Paediatric Patients with Type 1 Diabetes

Freya MacMillan, Alison Kirk, Nanette Mutrie

University of Strathclyde, Glasgow, Scotland, UK

Background to Type 1 diabetes

Type 1 diabetes also known as insulin-dependent diabetes or juvenile-onset diabetes, is an auto-immune disorder which targets the beta cells of the pancreas resulting in absolute deficiency of insulin. Insulin is the hormone which regulates blood glucose levels by stimulating glucose uptake into cells via transporters which move from vesicles inside cells to the cell membrane in response to insulin. If inadequate insulin is produced by the body and blood glucose levels are higher than normal (hyperglycaemia) then glucose levels will remain elevated or increase further unless external insulin is administered by injection or pump therapy. The American Diabetes Association, as well as insulin therapy, also advise diet, physical activity and regular blood glucose monitoring in the management of the condition (1).

Type 1 diabetes is more common in youth with the average age of onset being 14 years and the age at onset decreasing over time (2). Worldwide in 2010 there were approximately 285 million people with diabetes (Type 1 and Type 2) and the prevalence is estimated to rise to 438 million by 2030 (3). The worldwide incidence of Type 1 diabetes is rising by approximately 3% per year (4). Data from a literature review conducted by the International Diabetes Federation (2009) found that Finland has the highest incidence of Type 1 diabetes in children aged 0-14 years followed by Sweden, Norway then the UK respectively (4). It is important to note that in some areas of the world there is little or no data on diabetes prevalence (such as in parts of Africa) and thus these countries may be wrongly represented in incidence maps. The cause of the rise in prevalence is not clear but potential reasons for the increase include: perinatal factors, early life feeding patterns, gut microbiota, viruses and childhood growth patterns (5).

Health of people with Type 1 diabetes

Research has found that paediatric patients with Type 1 diabetes can have poorer health (6) and quality of life (7) outcomes when compared to their healthy peers. Cognitive functioning can also be poorer in those with Type 1 diabetes. Wennick and co-workers recently reported that childhood Type 1 diabetes was associated with lower levels of attained education (8). Those with Type 1 diabetes are also at an increased risk of developing cardiovascular disease and diabetic complications, with signs of complications appearing as early as 2-5 years after diagnosis (9). Diabetic

complications develop as a result of chronic hyperglycaemia which causes damage to tissues. Microvascular (small vessel) complications include retinopathy, neuropathy and nephropathy. Retinopathy affects the blood vessels of the eyes and can lead to visual impairment and blindness. Neuropathy targets the nervous system. Peripheral neuropathy affects the lower limbs and can lead to loss of sensation in the feet, an increased risk of foot ulcers and lower limb amputation. Autonomic neuropathy targets the autonomic system. Neuropathy can also affect other areas of the body resulting in problems such as erectile dysfunction and gastro intestinal complications. Nephropathy affects the kidneys and can result in kidney failure. Marcovascular complications include cardiovascular and cerebrovascular disease. The risk of cardiovascular disease is increased in the individual with Type 1 diabetes compared to healthy individuals (10-12).

Physical activity and Type 1 diabetes

Physical activity activates glucose uptake into cells in a non-insulin dependent pathway. Thus physical activity can lower blood glucose levels without the requirement of insulin. Balancing food intake with physical activity participation and the correct amount of insulin can be particularly challenging. If insulin levels are too high and the individual with Type 1 diabetes is physically active then blood glucose levels will fall below normal levels (hypoglycaemia). There is a risk of delayed hypoglycaemia in those with diabetes after physical activity, particularly if the activity has been of a long duration or high intensity, due to increased insulin sensitivity and delay in replenishing glycogen stores in the liver and muscles. Patients are advised to monitor blood glucose levels before they go to bed and to have a carbohydrate snack if required or to adjust insulin if necessary. If insulin levels are too low then physical activity can aggravate hyperglycaemia and result in ketoacid production leading to ketoacidosis.

Regular physical activity can result in physiological, psychological and social health benefits thus positively impacting on quality of life in youth. As some of these health outcomes can be poorer in patients with Type 1 diabetes the potential health benefits of being regularly physically active are particularly important for this population. In particular the beneficial effects of physical activity on cardiovascular risk factors (13, 14) and quality of life (15) have been found in studies of young people with Type 1 diabetes. The benefit of physical activity on glycaemic control is less clear with some supervised physical activity intervention studies finding improvements in control (14, 16, 17) and others finding no change (18-20).

Physical activity guidance and physical activity levels in paediatric patients with Type 1 diabetes

The physical activity recommendations for those with Type 1 diabetes are the same as for healthy children and adolescents; to achieve 60 minutes of at least moderate intensity physical activity each day of the week (21). In addition young people should aim to perform weight bearing activity on at least 3 days of the week (examples of this type of activity are running, skipping and jumping) and to minimise sedentary behaviour (21). Specific physical activity and exercise guidance in relation to blood glucose regulation exists for the young person with Type 1 diabetes (22, 23). Despite the known benefits some studies have found that paediatric patients with Type 1 diabetes do not meet the physical activity recommendations (15, 24-27) or that they are less active than their healthy peers (25, 26). The majority of the research that has found that those with Type 1 diabetes are less active than their peers used subjective measures of physical activity (questionnaires and recall diaries) which can be subject to recall bias. Of the previously mentioned studies, Maggio and colleagues (25) are the only group to have used accelerometers to objectively assess physical activity and sedentary behaviour in 48 individuals with Type 1 diabetes. They found that participants were only just achieving less than the recommended amount of physical activity per day (54.0±6.5 minutes of moderate to vigorous physical activity) with 38.5% of the sample actually achieving the guideline (above 60 minutes). However the sample size for accelerometer data was small with only 13 participants having enough data to be included in analysis. The study also included a physical activity questionnaire and interestingly participants reported only achieving a mean of 3.9±0.6 hours of activity.

Physical activity intervention in paediatric patients with Type 1 diabetes

Little research has explored the efficacy of physical activity interventions in paediatric patients with Type 1 diabetes. The majority of intervention studies have been supervised, conducted in controlled settings with short follow up periods (24 weeks or less). Although much can be learned from supervised, well-controlled studies, it is important to develop interventions which are not labour intensive and that can be realistically incorporated into diabetes care in order to have the greatest impact on this population. In addition longer follow up periods are required to explore adherence to interventions over the long term. Newton and colleagues (28) used pedometers and motivational text messaging in an unsupervised setting to try and increase participation over 12 weeks in 78 adolescents with Type 1 diabetes in New Zealand. The intervention was not successful at increasing participation measured by pedometer step counts or by a physical activity questionnaire. However participants were already exceeding the pedometer programme goal of achieving 10,000 steps/day at baseline, indicating that they were already physically active. Perhaps with more individualised goals which considered baseline activity

levels or if individuals who were less active were targeted then this intervention would have been more effective. Another issue highlighted by this group was that 17 participants in the intervention group lost their pedometers and a further 14 stopped wearing the pedometer before follow up highlighting poor adherence to the intervention. In Arizona Faulkner and colleagues (29) are currently testing a 16 week unsupervised intervention in adolescents with Type 1 diabetes which incorporates social cognitive and family systems theory as well as providing participants with an individualised exercise plan. Physical activity is being measured using accelerometers over the full 16 week period. In a sub-sample of 12 participants that have already completed the intervention they found that those who adhered to a frequency of 60 minutes of physical activity bouts per day had a significant increase in cardiovascular fitness. Participants achieved 60 minutes of moderate to vigorous physical activity on a mean of 45.5% of the total days that the accelerometer was worn over the 16 week period. Participants perceptions of family support measured by questionnaire also improved after the intervention. Particular strengths of this study are that it is the first to incorporate theory into the intervention and involve family support as well as being the first to deliver the intervention in a home or community setting. The challenges of recruiting paediatric patients with Type 1 diabetes into research studies has also been highlighted by Faulkner and et al. (29). Over a 16 month recruitment period approximately 20% of those that were approached to participate actually completed the study and more males were recruited than females.

Sedentary behaviour

Sedentary behaviour is increasingly being studied. Research has found mortality from all causes and cardiovascular disease is increased in a dose-response manner with increasing length of sedentary behaviour (sitting/lying down) independent of if they are meeting the physical activity recommendations (30). A study exploring sedentary behaviour in adolescents with Type 1 diabetes found more sedentary individuals to have poorer fitness, fat free mass, cholesterol and triglyceride levels (24). Therefore it is important to discourage sedentary behaviour in this population due to the possible health implications that can arise.

Qualitative research with paediatric patients with Type 1 diabetes

In order to create the most effective interventions the target group need to be consulted and involved in the development of interventions. Physical activity in general is under researched by qualitative methods. An Australian study exploring physical activity behaviour in children with chronic conditions included a sub-sample of children with Type 1 diabetes (31). They concluded that the children felt they could do anything that their healthy peers were able to do in relation to

physical activity and parents would do anything to make sure that their child was able to participate by advanced planning. A systematic review of qualitative research in adolescents with Type 1 diabetes conducted in 2009 (32) identified the need for research with significant figures in the patient's life to examine the importance of relationships and interactions on diabetes management.

Future recommendations

Recommendations for future research are to construct physical activity interventions based on theory and which target the important behavioural processes. In order to determine the key behavioural processes qualitative research with children and influential figures is required. Intervention studies should incorporate objective measures of physical activity and sedentary behaviour to determine their efficacy.

References

1. American Diabetes Association. Physical activity/exercise and diabetes. Diabetes Care. 2004;27(1):S58-S62.
2. Feltbower RG, McKinney PA, Parslow RC, Stephenson CR, Bodansky HJ. Type 1 diabetes in Yorkshire, UK: Time trends in 0-14 and 15-29 year olds, age at onset and age period cohort modelling. Diabetic Medicine. 2003;20:437-41.
3. Diabetes UK. Diabetes in the UK 2010: Key statistics on diabetes. 2010.
4. Soltesz G, Patterson C, Dahlquist G. Global trends in childhood type 1 diabetes. 2009.
5. Vehik K, Dabelea D. The changing epidemiology of type 1 diabetes: Why is it going through the roof? Diabetes/Metabolism Research and Reviews. 2010;27(1):3-13.
6. Williams BK, Guelfi KJ, Jones TW, Davis EA. Lower cardiorespiratory fitness in children with Type 1 diabetes. Diabetic Medicine. 2011;28(8):1005-7.
7. Kalyva E, Malakonaki E, Eiser C, Mamoulakis D. Health related quality of life (HrQoL) of children with type 1 diabetes mellitus (T1DM): Self and parental perceptions. Pediatric Diabetes. 2011;12:34-40.
8. Wennick A, Hallstrom I, Lindgren B, Bolin K. Attained educaion and self-assessed health later in life when diagnosed with diabetes in childhood: A population-based study. Pediatric Diabetes. 2011;12(7):619-26.
9. Cho YH, Craig ME, Hing S, Gallego PH, Poon M, Chan A, et al. Microvascular complications assessment in adolescents with 2 to 5 year duration of type 1 diabetes from 1990 to 2006. Pediatric Diabetes. 2011; Epub ahead of print.
10. Swerdlow AJ, Jones ME. Mortality during 25 years of follow-up of a cohort with diabetes. International Journal of Epidemiology. 1996;25:1250-61.
11. The British Diabetic Association Cohort Study. II: Cause specific mortality in patients with insulin-treated diabetes mellitus. Diabetic Medicine. 1999;16:466-71.
12. Margeirsdottir H, Larsen JR, Brunborg C, Overby NC, Dahl-Jorgensen K. High prevalence of cardiovascular risk factors in children and adolescents with type 1 diabetes: A population-based study. Diabetologia. 2008;51(4):554-61.
13. Herbst A, Bachran R, Kapellen T, Reinhard W. Effects of regular physical activity on control of glycemia in pediatric patients with Type 1 Diabetes Mellitus. Archives of Pediatrics and Adolescent Medicine. 2006;160:573-7.
14. Sideraviciute S, Gailiuniene A, Visagurskiene K, Vizbaraite D. The effect of long-term swimming program on body composition, aerobic capacity and blood lipids in 14-19-year aged healthy girls and girls with type 1 diabetes mellitus. Medicina. 2006;42(8):661-6.

15. Aman J, Skinner T, Beaufort C, Swift P, Aanstoot H, Cameron F. Associations between physical activity, sedentary behavior, and glycemic control in a large cohort of adolescents with type 1 diabetes: The Hvidoere Study Group on Childhood Diabetes. Pediatric Diabetes. 2009;10:234-9.
16. Salem MA, Aboelasrar MA, Elbarbary NS, Elhilaly RA, Refaat YM. Is exercise a therapeutic tool for improvement of cardiovascular risk factors in adolescents with type 1 diabetes mellitus? A randomised controlled trial. Diabetology & metabolic syndrome. 2010;2(1):47.
17. Ruzic L, Sporis G, Matkovic BR, Ruzic L, Sporis G, Matkovic BR. High volume-low intensity exercise camp and glycemic control in diabetic children. Journal of Paediatric Child Health. 2008;44(3):122-8.
18. Ramalho AC, de Lourdes Lima M, Nunes F, Cambui Z, Barbosa C, Andrade A, et al. The effect of resistance versus aerobic training on metabolic control in patients with type-1 diabetes mellitus. Diabetes Research and Clinical Practice. 2006;72(3):271-6.
19. Woo J, Yeo NH, Shin KO, Lee HJ, Yoo J, Kang S. Antioxidant enzyme activities and DNA damage in children with type 1 diabetes mellitus after 12 weeks of exercise. Acta Paediatrica. 2010;99(8):1263-8.
20. Roberts L, Jones TW, Fournier PA. Exercise training and glycemic control in adolescents with poorly controlled type 1 diabetes mellitus. Journal of pediatric endocrinology & metabolism. 2002; 15 (5):621-7
21. Department of Health Physical Activity Health Improvement and Protection. Start active, stay active: A report on physical activity for health from the four home countries' Chief Medical Officers. Crown copyright; 2011.
22. Robertson K, Adolfsson P, Scheiner G, Hanas R, Riddell M. Exercise in children and adolescents with diabetes. Pediatric Diabetes. 2009;10(12):154-68.
23. Runsweet.com: Diabetes and sport. [http://www.runsweet.com].
24. Michaliszyn SF, Faulkner MS. Physical activity and sedentary behavior in adolescents with type 1 diabetes. Research in Nursing and Health. 2010;33(5):441-9.
25. Maggio A, Hofer M, Martin X, Marchand L, Beghetti M, Farpour-Lambert N. Reduced physical activity level and cardiorespiratory fitness in children with chronic diseases. European Journal of Pediatrics. 2010;169:1187-93.
26. Valerio G, Spagnuolo M, Lombardi F, Spadaro R, Siano M, Franzese A. Physical activity and sports participation in children and adolescents with type 1 diabetes mellitus. Nutrition, metabolism and cardiovascular diseases 2007;17(5):376-82.
27. Schweiger B, Klingensmith G, Snell-Bergeon J. Physical activity in adolescent females with type 1 diabetes. International Journal of Pediatrics. 2010; Epub ahead of print.
28. Newton KH, Wiltshire EJ, Elley CR. Pedometers and text messaging to increase physical activity: Randomized controlled trial of adolescents with type 1 diabetes. Diabetes care. 2009;32(5):813-5.
29. Faulkner MS, Michaliszyn SF, Hepworth JT. A personalized approach to exercise promotion in adolescents with type 1 diabetes. Pediatric diabetes. 2010;11(3):166-74.
30. Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease and cancer. Medicine & Science in Sports & Exercise. 2009;41(5):998-1005.
31. Fereday J, MacDougall C, Spizzo M, Darbyshire P, Schiller W. "There's nothing I can't do - I just put my mind to anything and I can do it": A qualitative analysis of how children with chronic disease and their parents account for and manage physical activity. Pediatrics. 2009;9:1.
32. Spencer J, Cooper H, Milton B. Qualitative studies of type 1 diabetes in adolescence: A systematic literature review. Pediatric Diabetes. 2010;11:(364-375).