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Epidemiology

Participation in Special Olympics reduces the rate for developing diabetes in adults with intellectual and developmental disabilities

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Abstract

Aim: Adults with intellectual and developmental disabilities (IDD) have a significantly higher prevalence of Type 2 diabetes than the general population. Evidence that lifestyle and/or behavioural interventions, such as participation in Special Olympics, decreases the risk of developing diabetes in adults with IDD could help minimize health disparities and promote overall health in this population.

Methods: This was a 20-year retrospective cohort study of adults with IDD (30–39 years) in the province of Ontario, Canada, that compared hazard rates of diabetes among Special Olympics participants ($n = 4145$) to non-participants ($n = 31{,}009$) using administrative health databases housed at ICES. Using cox proportional hazard models, crude and adjusted hazard ratios were calculated for the association between the primary independent variable (Special Olympics participation status) and the dependent variable (incident diabetes cases).

Results: After controlling for other variables, the hazard ratio comparing rates for developing diabetes between Special Olympics participants and non-participants was 0.85. This represents a 15% reduction in the hazard among Special Olympics participants when followed for up to 20 years. This result was statistically significant and represents a small effect size.

Conclusions: Special Olympics could be considered a complex intervention that promotes physical activity engagement through sport participation, health screenings, and the promotion of healthy eating habits through educational initiatives. This study provides evidence that Special Olympics participation decreases the rate for developing diabetes.

KEYWORDS

complex intervention, developmental disabilities, diabetes, Health promotion, intellectual disabilities, physical activity, Special Olympics

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1 | INTRODUCTION

Diabetes is a chronic condition in which a person consistently experiences high blood sugar levels due to the body's inability to produce, or properly use, insulin and can lead to serious health complications.[1] The Public Health Agency of Canada reports that approximately 8.1% of the population lives with a diagnosis of diabetes, and it is estimated that 90% of diabetes cases are Type 2.[1] The increasing prevalence of diabetes in the general population has been associated with increases in co-occurring medical conditions (e.g., kidney failure, cardiovascular disease) and extremely high health care expenditures.[2,3] One subgroup of the population that has consistently been found to have higher prevalence of diabetes is people with intellectual and developmental disabilities (IDD).[4–7]

Individuals with intellectual disabilities are a subgroup of the population who have neurodevelopmental disorders that are characterized by (a) limitations in intellectual functioning, (b) limitations in adaptive functioning, and (c) onset during developmental years.[8] The legislative definition for individuals with developmental disabilities in Ontario, Canada includes limitations in cognitive and adaptive functioning and these limitations (a) began before the person reached 18 years of age, (b) are expected to be life-long in nature, and (c) affect areas of major life activity, such as personal care, language skills, the ability to live independently as an adult or any other prescribed activity.[9] Consistent with past research, the term IDD will be used in this paper.[10,11] In Ontario, Canada, where this study took place, the adult population with IDD makes up approximately 0.8% of the provincial population.[12]

1.1 | IDD and Diabetes

While a wide range of values are reported in the literature for prevalence of diabetes among people with IDD, the research consistently indicates that adults with IDD have a higher prevalence of diabetes compared to the general population.[4–7] A systematic review of 22 studies by McRae and colleagues[13] found that prevalence of diabetes for people with IDD ranged from 4.5% to 18.5% in Canada and the United States, with an average rate of 8.3%. The wide range of reported prevalence from these studies can be partially explained by the differing definitions of IDD used, and different age groups. A more recent meta-analysis on the prevalence of diabetes in people with IDD found that the prevalence of diabetes was 8.5% amongst a sample of 55,548; a finding that is 2.46 times higher than people without IDD.[7] Balogh and colleagues[4] used administrative health databases in Ontario, Canada to examine the prevalence of diabetes in people with IDD (n = 28,567) and the general population of people without IDD. Results indicated that 16.0% of people with IDD had diabetes compared to 9.7% of people without IDD. Further, the difference in diabetes prevalence was most prominent in younger age groups; for example, in 30–39 year olds, 8.9% of people with IDD had diabetes and only 3.2% of people without IDD had diabetes.[4] A large Dutch study published in 2021, also using administrative health databases, compared a cohort with IDD (n = 21,203) to a matched control group from the general population.[6] They found that the prevalence of diabetes was higher in the population with IDD (9.9%) compared to the general population (6.6%) or approximately 1.5 times higher.

It is unclear why people with IDD have higher rates of diabetes.[14] However, the literature is quite clear that overweight and obesity are pervasive challenges in this population.[15-17] While there are some specific conditions that have particularly high rates of overweight and obesity (e.g., Prader–Willi syndrome, Down syndrome)[18,19] it is likely that societal and lifestyle factors related to overweight and obesity in people with IDD are primary driving factors.[20] The published literature consistently indicates low levels of physical activity in this population,[21,22] and people with IDD are more likely to live in a supportive living environment possibly contributing to the quality and quantity of the food available.[23] Finally, people with IDD are also often prescribed medications known to contribute to weight gain and obesity (e.g., antipsychotic medications).[24] Therefore, biological, lifestyle, and pharmacological factors all could reasonably impact the very high rates of obesity in people with IDD, thereby contributing to the high rates of diabetes in this population.

Research has also found that management of diabetes in this population is often very poor.[25] Balogh and colleagues[4] found that adults with IDD were 2.6 times

What's new

- People with intellectual and developmental disabilities (IDD) have very high rates of diabetes.
- This study found a 15% rate reduction in diabetes for adults with IDD who participate in Special Olympics, compared to adults with IDD who do not participate, over a period of up to 20 years.
- Special Olympics is a relatively low-cost intervention (compared to the cost of treating diabetes), and our results indicate there is a significant health promoting effect to participation.

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more likely to be hospitalized for diabetes related complications than the general population. The strategies to manage Type 2 diabetes have been well studied in the general population.[26] However, less is known about the effectiveness of these strategies for people with IDD.[27,28] It is widely accepted that overweight/obesity status and engagement in physical activity are two important factors in the management and prevention of Type 2 diabetes.[26] Individuals with IDD have consistently been found to have high rates of overweight and obesity,[15,17] and engage in less physical activity than the general population.[21] In the general population, interventions that include exercise and education on a healthy diet have been shown to help prevent Type 2 diabetes,[26] and are very cost-effective.[3] However, diabetes prevention strategies used for the general population may not translate well for people with IDD.[27,28] A more targeted approach for decreasing risk factors, in an accessible format, is necessary for this population since the ability to make lifestyle changes is not always possible for adults with IDD.[27,28] The cognition, adaptability, freedom, and autonomy that most adults take for granted, is not necessarily a reality for people with IDD.[25,28]

1.2 | Special Olympics

Special Olympics is an international organization that promotes physical activity, sport participation, health literacy, health screenings, and social connectedness for people with IDD.[11] Special Olympics held its first sporting event in 1968, and in the subsequent decades the organization has provided high quality, accessible, sporting opportunities for people with IDD locally in communities, as well as nationally, and internationally. Special Olympics offers a wide variety of sports, including individual sports (e.g., swimming) and team sports (e.g., basketball); they also offer developmental programmes for children and youth. Most Special Olympics programming is recreational and opportunities to train, practice, and compete occur regularly at the local community level. In addition to providing physical activity and sport opportunities, Special Olympics also has a focus on inclusion and acceptance with strong social[29] and health promotion components[30] all at low, or no-cost, to participants. Special Olympics is unique in that participants can enter, and participate, at any time across the lifespan, and there is no prerequisite skill level for participation. Furthermore, once participants engage with Special Olympics they often participate for life.[31] Walsh and colleagues[21] compared the physical activity of individuals with IDD who participated ($n = 101$), or did not participate ($n = 45$), in Special Olympics. They found that Special Olympics participants accumulated more moderate-vigorous physical activity daily, had higher cardiorespiratory fitness scores, and a more positive health profile score. Evidence indicates that adults with IDD, who do not participate in Special Olympics, have high rates of overweight and obesity.[32] There is evidence that adults with IDD, who participate in Special Olympics, also have high rates of overweight and obesity,[15,17] despite being more active. Special Olympics also generates opportunities to form social relationships, gain mentorship, and access health promotion activities.[33,34] We propose that participation in Special Olympics is a complex population-level intervention which promotes positive health outcomes for participants.[11]

It is hypothesized that Special Olympics may have a health promoting effect that contributes to the prevention of diabetes. No studies have explored the impact of physical activity, or participation in Special Olympics, on diabetes in adults with IDD at the population level. The purpose of this study was to compare the hazard rates of diabetes among adult Special Olympics participants with IDD compared to non-participants with IDD.

2 | METHODOLOGY

Approval to conduct this study was obtained from the Research Ethics Board at Ontario Tech University, REB approval: 13550–(14–125). Additionally, an extensive privacy assessment was conducted by ICES (formerly the Institute for Clinical Evaluative Sciences).

2.1 | Study design

This 20-year retrospective cohort compared the rate of developing diabetes in Special Olympics participants to non-participants from April 1st, 1995 to March 31st, 2015 in Ontario, Canada.

2.2 | Data sources

The datasets used in this study were linked using unique encoded identifiers and analysed at ICES.[10,11,35,36] ICES is a non-profit independent research institute that maintains population-based administrative data of Ontarians eligible for health services.[35] The use of these data was authorized under Section 45 of the Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board. The data at ICES are held in a secured environment; policies and procedures approved by the Ontario Privacy Commissioner make it possible for scientists and clinicians to access the data for research purposes.[35,36]

2.3 | Identification of persons with IDD and Special Olympics participants

Adults with IDD were identified using algorithms and diagnostic codes applied to five health databases that are linked and housed at ICES.[37] The diagnostic codes were those for intellectual disability found in the 9th and 10th revisions of the International Classification of Diseases (Table 1).[11] The codes for conditions that are commonly associated with intellectual disability (e.g., Down syndrome), and conditions commonly associated with developmental disability (e.g., autism spectrum disorder) were also included.[10] The method used to identify persons with IDD from within ICES health databases has been used in several previously published studies.[10,11,37]

Individuals with an IDD who participate in Special Olympics Ontario were also identified within the administrative health databases held by ICES.[10,11,36] This identification was made possible by transferring data from a registry of Special Olympics Ontario participants to ICES, where records from the registry were linked to the existing databases held at ICES.[10,11]

2.4 | Primary dependent and independent variables

The primary dependent variable was diabetes diagnosis status. Incident cases of diabetes were identified from the Ontario Diabetes Database. The algorithm used to identify people with diabetes for the Ontario Diabetes Database was validated by Lipscombe et al.[38] The Ontario Diabetes Database includes all Ontarians with any type of non-gestational diabetes since 1991. The case definition was (1) at least one hospitalization with a diagnosis code ICD-9: 250 (diabetes mellitus without mention of complications or type mentioned) or ICD-10: E10 (Type 1 diabetes mellitus), E11 (Type 2 diabetes mellitus), E13 (other specified diabetes mellitus), E14 (unspecified diabetes mellitus); or (2) two Ontario Health Insurance Plan diagnosis code 250 in 1 year; or (3) 1 Ontario Drug Benefit claim for diabetes mellitus medication in a one-year period.[38] No participant, in either group, had a diagnosis of diabetes ever recorded in the Ontario Diabetes Database prior to the index date. The primary independent variable was Special Olympics participation status. In order to be considered a participant, an individual needed to have participated in Special Olympics for at least 1 year over the study duration (otherwise they

TABLE 1 International Classification of Diseases, 9th and 10th edition Codes for Identifying IDD.

Code	Label
ICD-9	
299–299.99	Pervasive developmental disorders
317–317.99	Mental retardation
318–318.99	Mental retardation
319–319.99	Mental retardation
758.0–758.39	Chromosomal anomalies for which a developmental disability is typically present
758.8–758.89	Other conditions due to chromosome anomalies (do not include 758.81)
758.9	Conditions due to anomaly of unspecified chromosome
759.5	Tuberous sclerosis
759.81	Other and unspecified congenital anomalies: Prader–Willi syndrome
759.821	Other and unspecified congenital anomalies: de Lange syndrome
759.827	Other and unspecified congenital anomalies: Seckel syndrome
759.828	Other and unspecified congenital anomalies: Smith–Lemli–Opitz syndrome
759.83	Other and unspecified congenital anomalies: Fragile X syndrome
759.874	Other and unspecified congenital anomalies: Beckwith–Wiedemann syndrome
759.875	Other and unspecified congenital anomalies: Zellweger syndrome
759.89	Other and unspecified congenital anomalies: other
760.71	Foetal alcohol syndrome
760.77	Foetal hydantoin syndrome
ICD-10	
F700	Mild mental retardation with the statement of no, or minimal, impairment of behaviour
F701	Mild mental retardation, significant impairment of behaviour requiring attention or treatment
F708	Mild mental retardation, other impairments of behaviour
F709	Mild mental retardation without mention of impairment of behaviour
F710	Moderate mental retardation with the statement of no, or minimal, impairment of behaviour

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TABLE 1 (Continued)

Code	Label
F711	Moderate mental retardation, significant impairment of behaviour requiring attention or treatment
F718	Moderate mental retardation, other impairments of behaviour
F719	Moderate mental retardation without mention of impairment of behaviour
F720	Severe mental retardation with the statement of no, or minimal, impairment of behaviour
F721	Severe mental retardation, significant impairment of behaviour requiring attention or treatment
F728	Severe mental retardation, other impairments of behaviour
F729	Severe mental retardation without mention of impairment of behaviour
F730	Profound mental retardation with the statement of no, or minimal, impairment of behaviour
F731	Profound mental retardation, significant impairment of behaviour requiring attention or treatment
F738	Profound mental retardation, other impairments of behaviour
F739	Profound mental retardation without mention of impairment of behaviour
F780	Other mental retardation with the statement of no, or minimal, impairment of behaviour
F781	Other mental retardation, significant impairment of behaviour requiring attention or treatment
F788	Other mental retardation, other impairments of behaviour
F789	Other mental retardation without mention of impairment of behaviour
F790	Unspecified mental retardation with the statement of no, or minimal, impairment of behaviour
F791	Unspecified mental retardation, significant impairment of behaviour requiring attention or treatment
F798	Unspecified mental retardation, other impairments of behaviour
F799	Unspecified mental retardation without mention of impairment of behaviour
F840	Childhood autism
F841	Atypical autism

(Continues)

TABLE 1 (Continued)

Code	Label
F843	Other childhood disintegrative disorder
F844	Overactive disorder associated with mental retardation and stereotyped movements
F845	Asperger's syndrome
F848	Other pervasive developmental disorders
F849	Pervasive development disorder, unspecified
Q851	Tuberous sclerosis
Q860	Foetal alcohol syndrome
Q861	Foetal hydantoin syndrome
Q871	Aarskog, Prader–Willi, deLange, Seckel, etc.
Q8723	Rubinstein–Taybi syndrome
Q8731	Sotos syndrome
Q878	Other
Q900-Q939 except Q926	All Down syndrome types
Q971	Female with more than three X chromosomes
Q992	Fragile X syndrome
Q998	Other specified chromosome abnormalities

were considered a non-participant). Once this condition was met, Special Olympics status was treated as a time-varying variable, updated yearly.

2.5 | Other variables

Several demographic and clinical variables were included in the analysis to control for their possible role as confounders.[11] Sex was included as a dichotomous variable (male vs. female). Place of residence was defined as being either rural vs. urban using the Postal Code Conversion File from Statistics Canada, where a community size of ≤10,000 was considered rural, and all other communities were considered urban.[39] Relative neighbourhood affluence was derived from the Canadian Census; specifically for dates between 1994 and 1998, it was derived from the 1996 Census population data; for dates from 1999 to 2003, it relied on the 2001 Census; from 2004 to 2008, it was based on the 2006 Census; from 2009 to 2015, it utilized the 2011 Census data. Regions of Ontario were ranked from poorest to wealthiest and then divided into 5 groups (quintiles, poorest = 1 and wealthiest = 5). The John Hopkins

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Adjusted Clinical Group system®, version 10, was used to cluster individuals into levels of morbidity referred to as Resource Utilization Bands. The band values range from 0 to 5: 0 (no or only invalid diagnoses), 1 (healthy users), 2 (low morbidity), 3 (moderate morbidity), 4 (high morbidity) and 5 (very high morbidity).[40] They are a simplified, commonly used, ranking system of overall morbidity level where individuals who are expected to use the same level of resources are grouped together, even if they have different illnesses.[40-42] Resource Utilization Bands are used as a relative measure of actual or expected consumption of health services, and are also used to represent health status and levels of morbidity.[40-42] We controlled for age in the analysis by using age as the time scale rather than time-on-study. Using age as the time scale means that the statistical model computed hazard estimates for all those of a given age, regardless of when a person turns that age; for instance, if a person turned 30 in 1999 and another person turned 30 in 2005, those individuals would be compared to each other at age 30, regardless of when that happened. This method was recently used in a similar paper addressing depression in Special Olympics participants with IDD.[11] Finally, we included the calendar year of the 30th birthday in the model to control for potential calendar year effects (e.g., cultural lifestyle and health changes, medical advances).

2.6 | Analysis

Incident cases of diabetes were identified in a cohort of 30–39-year-old Ontarians with IDD, who were followed for a maximum of 20 years between April 1, 1995 and March 31, 2015. A 39-year-old at study start could thus contribute 20 years of follow-up and be 59 by the end of the study. Individuals started contributing to the risk set on the index date. The index date was an individual's 30th birthday if that date was after April 1, 1995; if an individual's 30th birthday was before April 1, 1995, then the index date was April 1, 1995.

Using index date as the baseline, demographic and clinical characteristics of Special Olympics participants and non-participants were tabulated with means and standard deviations calculated for continuous data and counts and proportions for categorical data (Table 2). Standardized differences were also calculated for variables in Table 2, where values less than 0.2 were considered small effect sizes. Incidence densities were calculated using person-years contributed by individuals during the follow-up.

We used two steps to build a statistical model to determine the strength of association between the primary independent variable (Special Olympics participation yes vs. no) and the dependent variable (diabetes diagnosis yes vs. no). Using cox proportional hazard models, we first

TABLE 2 Participant characteristics at the cohort entry.

Variable	Value	Special Olympics participants	Non-participants	Standardized differences
Sample size		$N = 4145$	$N = 31{,}009$	
Mean age ± SD (years)		30.0 ± 0.5	31.7 ± 2.8	
Median age		30 (30–30)	30 (30–33)	
Sex	Female	1600 (38.6%)	13,639 (44.0%)	0.11
	Male	2545 (61.4%)	17,370 (56.0%)	0.11
Income quintile	Missing	27 (0.7%)	495 (1.6%)	0.09
	1 (poorest)	1022 (24.7%)	8594 (27.7%)	0.07
	2	851 (20.5%)	6792 (21.9%)	0.03
	3	759 (18.3%)	5583 (18.0%)	0.01
	4	755 (18.2%)	5205 (16.8%)	0.04
	5 (wealthiest)	731 (17.6%)	4340 (14.0%)	0.10
Rural vs. Urban	Missing	15 (0.4%)	134 (0.4%)	0.01
	Urban	3362 (81.1%)	26,104 (84.2%)	0.08
	Rural	768 (18.5%)	4771 (15.4%)	0.08
Resource utilization band	0	338 (8.2%)	3020 (9.7%)	0.06
	1	271 (6.5%)	1190 (3.8%)	0.12
	2	738 (17.8%)	4017 (13.0%)	0.13
	3	2261 (54.5%)	15,299 (49.3%)	0.10
	4	451 (10.9%)	5964 (19.2%)	0.24
	5	86 (2.1%)	1519 (4.9%)	0.15

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calculated the crude hazard ratios for the association between each independent variable and the dependent variable.[11] Second, we included multiple independent variables in a single model to determine if the strength of the association between Special Olympics status and diabetes diagnosis remained significant after adjusting for the covariates. As for Special Olympics participation status, the variables income level, rurality, and morbidity level were entered as time varying variables, updated yearly.[11] Cumulative hazard plots are provided to visually present the results.

3 | RESULTS

3.1 | Characteristics of Special Olympics participants and non-participants

This cohort included 35,154 adults with IDD identified by ICES and Special Olympics data (Table 2). At cohort entry, there were 4145 Special Olympics participants and 31,009 non-participants. Standardized differences were calculated on all variables comparing the two groups and there were no meaningful differences (effect size <0.2) with one exception. The comparison of Resource Utilization Band 4 between the two groups found an effect size of 0.24, which indicates that the non-participants had higher levels of morbidity than the Special Olympics participants (Table 2).

3.2 | Incidence density of diabetes

There were 3742 cases of diabetes among non-participants, and 561 cases of diabetes among Special Olympics participants. The crude incidence density per 1000 person-years was 11.01 for non-participants, and 8.41 for Special Olympics participants.

3.3 | Model results

After controlling for other variables, the adjusted hazard ratio comparing participants to non-participants was 0.85 (Table 3). Thus, participating in Special Olympics was associated with a 15% reduction in the hazard for developing diabetes ($p=0.0003$), with a small effect size. Cumulative hazard plots are presented in Figure 1. There was a 10%

TABLE 3 Crude and adjusted ratios comparing hazard rates for diabetes in Special Olympics participants to non-participants.

		Crude hazard ratio		Adjusted hazard ratio[a]	
Parameter	Value	Hazard ratio (95% confidence ratio)	*p*-value	Hazard ratio (95% confidence ratio)	*p*-value
Special Olympics participants	No	Ref		Ref	
	Yes	0.77 (0.71–0.85)	<0.0001	0.85 (0.77–0.93)	<0.0003

[a]Adjusted for sex, affluence, rural vs. urban residence, resource utilization band, calendar year of 30th birthday.

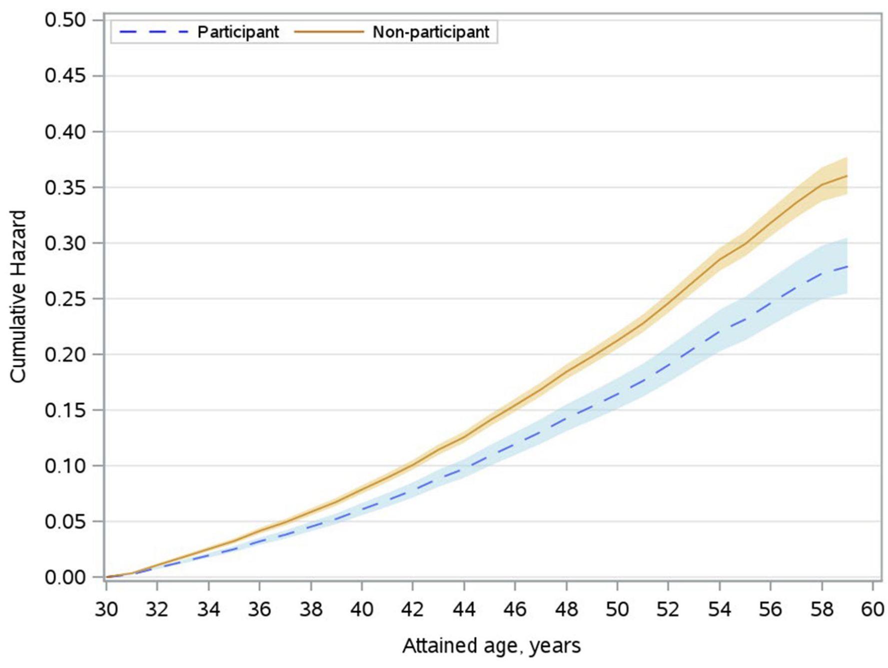

FIGURE 1 Cumulative hazard for developing diabetes, Special Olympics participant vs. non-participant.

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difference between the crude and adjusted hazard ratios (0.77 vs. 0.85), indicating that important cofounders were controlled for in the full model.

4 | DISCUSSION

The purpose of this study was to compare the rates of diabetes among adult Special Olympics participants with IDD compared to non-participants with IDD. We found a 15% reduction in the hazard for developing diabetes in adults with IDD, who participated in Special Olympics compared to those who do not participate in Special Olympics when sex, rurality, affluence, morbidity, year of 30th birthday, and age were all controlled for. These findings provide evidence that participating in Special Olympics is beneficial for the physical health of the participants, specifically as it relates to diabetes and its sequelae.

Special Olympics may be described as a complex intervention. Clark[43] defines complex interventions as being composed of parts that make the whole intervention and, in isolation or in combination, can create the context for an effective intervention. Special Olympics is a sport organization, but more recently it has been providing health screenings and educational opportunities to promote fitness, and well-being. Specifically, in Ontario, health screenings began in 1997 at major games and have become a more integrated part of the Special Olympics Ontario programming in the past 10 years. Therefore, it is difficult to determine exactly what part of participation in Special Olympics is beneficial for preventing diabetes. Engagement in regular physical activity likely has a protective effect for diabetes,[26] it is also possible that educational opportunities around healthy eating and overall health promotion initiatives also have an impact.[43] However, for this study we do not know what supplementary types of programing the Special Olympics participants were a part of. We also do not know if participants, in either group, engaged in regular physical activity outside of Special Olympics. Previous research has found that people with IDD who participate in Special Olympics are more active,[21] and participate in multiple sports.[44] While we do not know exactly what it is about Special Olympics that is important in preventing diabetes, we propose it is likely the interaction of all the factors rather than one individual causal agent. We hypothesize that the effect found in this study is a result of the interaction of engaging in a sporting activity chosen by the participants (e.g., soccer), combined with the activities of daily living that accompany the sport participation (e.g., walking to and from the bus stop for practice), the health and educational programing that often co-occur at competitions (e.g., health screenings and education held at regional events), as well as the informal interactions with coaches and other supportive individuals (e.g., being encouraged to drink water vs. a high sugar sports drink at practice). Multi-sectoral approaches have shown promise for preventing diabetes and their implementation could lead to cost savings.[26] A recent systematic review and meta-analysis found that, in the general population, interventions that include exercise/physical activity as well as education on a healthy diet are effective in preventing Type 2 diabetes.[26] The results from our study suggests that these types of intervention, tailored to people with IDD, may benefit people with IDD in a similar way.

A number of limitations to this study need to be acknowledged. At baseline, the effect size comparing the groups for the 4th Resource Utilization Band was 0.24, indicating the non-participants had higher levels of morbidity. Like other potential confounders, Resource Utilization Band was controlled for in our adjusted hazard model. This may have contributed to the attenuation of the hazard ratio, but the protective effect of participating in Special Olympics remained significant. Even for the variables included in the model, residual confounding remains a concern due to the use of broad categories and proxy variables (e.g., Resource Utilization Bands). The scale (Resource Utilization Bands) used to gauge the health and morbidity of adults with IDD does not give information on the severity of disability.[41] Therefore, it is possible that adults who participate in Special Olympics may have a less severe disability, requiring lower levels of support, which may contribute to the lower morbidity levels found at baseline. It is a limitation of this study that level of disability is not available to be used as a control variable in the analysis. We could find no evidence in the literature that the risk for diabetes varies with severity level of IDD[7]; however, future research should investigate this further. More research is also needed using rigorous study designs (e.g., randomized clinical trials) to determine the components of Special Olympics participation that have the greatest impact on health. Using administrative data to conduct this research has benefits in terms of the large sample size and fewer costs in comparison to other designs; future research using administrative databases should try to include more social and biological information if possible. It is also recommended that researchers from other jurisdictions attempt to replicate our results and seek to address some of the identified limitations by, for example reporting BMI, and IDD severity level. Our study did not differentiate between Type 1 and Type 2 diabetes. Type 1 diabetes makes up only approximately 5%–15% of the population with diabetes,[45] and a large proportion of those are diagnosed in childhood.[46] In this study, no participant in

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either group had a diagnosis of diabetes at the start of the cohort and all participants were 30–39 years of age when the cohort began. For these reasons, most incident cases of diabetes among the participants and non-participants in this study would be attributable to Type 2 diabetes. If there was a disproportionate number of people who developed Type 1 diabetes among the non-participants, the influence would be minimal. A final limitation of this study is that no information was available regarding the BMI status of the participants in either group; this is an important risk factor for diabetes,[47] and it may be possible to obtain this information in the future when different databases become available for linking.

5 | CONCLUSION

Our study found a 15% rate reduction in diabetes for adults with IDD who participate in Special Olympics, compared to adults with IDD who do not participate, over a period of up to 20 years. Consistent with the cohort design, no participants in either group had a diabetes diagnosis at study onset. Other strengths of the study include the large sample size and the use of a validated algorithm to identify diabetes from administrative health databases.[38] Due to the high prevalence of diabetes in this population,[4-6] the lack of other effective diabetes prevention strategies,[25,27,28] and the overwhelming cost of diabetes to the health care system,[2,3] this result is meaningful. There is strong evidence in the literature related to the economic burden of physical inactivity, and there is also overwhelming evidence that physical activity is a cost-effective intervention for reducing the morbidity and mortality resulting from non-communicable diseases,[48-50] including diabetes.[51] Special Olympics is a relatively low-cost physical activity intervention (compared to the cost of treating diabetes), and our results indicate there is a significant health promoting effect to participation. Future research should explore the healthcare costs related to diabetes relative to the cost of Special Olympics programming to delineate the actual cost savings of reducing the rate of diabetes in adults with IDD by 15%. Clinicians, educators, and people with IDD themselves should consider Special Olympics participation to promote health. Future studies should investigate if ongoing participation from childhood through adulthood has an even greater preventive effect on diabetes and other health variables compared to those with an IDD who do not participate.

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CONFLICT OF INTEREST STATEMENT

Dr. Yona Lunsky joined the Board of Directors of Special Olympics Canada in 2019. Special Olympics Canada provided a small research grant to Dr. Balogh and Dr. Lloyd in 2015. Dr. Lunsky was invited to join the research team in 2016 after the grant was awarded, and before she joined the Board of Directors. Neither Special Olympics Canada, or Special Olympics Ontario were involved in the data analysis or interpretation of the results of this study. All the other authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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REFERENCES

1. *Diabetes in Canada: Highlights from the Canadian Chronic disease surveillance system (Her Majesty the Queen in Right of Canada, as represented by the Minister of Health, 2017)*. 2017.
2. Williams R, Karuranga S, Malanda B, et al. Global and regional estimates and projections of diabetes-related health expenditure: results from the international diabetes federation diabetes atlas. *Diabetes Res Clin Pract*. 2020;162:108072. doi:10.1016/j.diabres.2020.108072
3. Zhou X, Siegel KR, Ng BP, et al. Cost-effectiveness of diabetes prevention interventions targeting high-risk individuals and whole populations: a systematic review. *Diabetes Care*. 2020;43(7):1593-1616. doi:10.2337/dci20-0018
4. Balogh R, Lake J, Lin E, Wilton A, Lunsky Y. Disparities in diabetes prevalence and preventable hospitalizations in people with intellectual and developmental disability: a population-based study. *Diabet Med*. 2015;32(2):235-242. doi:10.1111/dme.12573

14645491, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/dme.15393 by Meghann Lloyd , Wiley Online Library on [25/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

5. Tyrer F, Ling S, Bhaumik S, et al. Diabetes in adults with intellectual disability: prevalence and associated demographic, lifestyle, independence and health factors. *J Intellect Disabil Res*. 2020;64(4):287-295. doi:10.1111/jir.12718
6. Cuypers M, Leijssen M, Bakker-van Gijssel EJ, et al. Patterns in the prevalence of diabetes and incidence of diabetic complications in people with and without an intellectual disability in Dutch primary care: insights from a population-based data-linkage study. *Prim Care Diabetes*. 2021;15(2):372-377. doi:10.1016/j.pcd.2020.11.012
7. Vancampfort D, Schuch F, Van Damme T, et al. Prevalence of diabetes in people with intellectual disabilities and age-and gender-matched controls: a meta-analysis. *J Appl Res Intellect Disabil*. 2022;35(2):301-311. doi:10.1111/jar.12949
8. American Association on Intellectual and Developmental Disabilities. *Intellectual Disability: Definition, classification, and systems of supports (11th ed)*. American Association on Intellectual and Developmental Disabilities; 2010.
9. *Services and Supports to Promote the Social Inclusion of Persons with Developmental Disabilities Act, 2008. S.O. 2008, c. 14 (2008)*.
10. Lloyd M, Dobranowski K, Cheng SY, et al. Matching Special Olympics registration data with administrative health databases: feasibility and health status differences in children and youth with IDD. *Disabil Health J*. 2022;15:101319.
11. Lloyd M, Temple VA, Foley JT, et al. Young adults with intellectual and developmental disabilities who participate in Special Olympics are less likely to be diagnosed with depression. *Soc Psychiatry Psychiatr Epidemiol*. 2022;1-10:1699-1708.
12. Lin E, Balogh RS, Isaacs B, et al. Strengths and limitations of Health and disability support administrative databases for population-based Health Research in intellectual and developmental disabilities. *J Policy Pract Intellect Disabil*. 2014;11(4):235-244.
13. MacRae S, Brown M, Karatzias T, et al. Diabetes in people with intellectual disabilities: a systematic review of the literature. *Res Dev Disabil*. 2015;47:352-374. doi:10.1016/j.ridd.2015.10.003
14. Vancampfort D, Schuch F, Van Damme T, et al. Metabolic syndrome and its components in people with intellectual disability: a meta-analysis. *J Intellect Disabil Res*. 2020;64(10):804-815. doi:10.1111/jir.12772
15. Foley JT, Lloyd M, Temple VA. Body mass index trends among adult U.S. special olympians, 2005-2010. *Adapt Phys Activ Q*. 2013;30(4):373-386.
16. Lloyd M, Foley JT, Temple VA. Body mass index of children and youth with an intellectual disability by country economic status. *Prev Med*. 2014;69C:197-201. doi:10.1016/j.ypmed.2014.10.010
17. Temple VA, Foley JT, Lloyd M. Body mass index of adult special Olympians by country economic status. *J Policy Pract Intellect Disabil*. 2015;12(4):235-243. doi:10.1111/jppi.12123
18. Muscogiuri G, Barrea L, Faggiano F, et al. Obesity in Prader-Willi syndrome: physiopathological mechanisms, nutritional and pharmacological approaches. *J Endocrinol Invest*. 2021;44(10):2057-2070. doi:10.1007/s40618-021-01574-9
19. Ptomey L, Walpitage D, Mohseni M, et al. Weight status and associated comorbidities in children and adults with down syndrome, autism spectrum disorder and intellectual and developmental disabilities. *J Intellect Disabil Res*. 2020;64(9):725-737. doi:10.1111/jir.12767
20. Schenkelberg MA, Clarke EC, Wasser H, et al. A call for obesity prevention interventions for young children with intellectual and developmental disabilities. *Transl Behav Med*. 2023;13(11):817-819. doi:10.1093/tbm/ibad043
21. Walsh D, Belton S, Meegan S, et al. A comparison of physical activity, physical fitness levels, BMI and blood pressure of adults with intellectual disability, who do and do not take part in Special Olympics Ireland programmes: results from the SOPHIE study. *J Intellect Disabil*. 2018;22(2):154-170. doi:10.1177/1744629516688773
22. Bossink LW, van der Putten AA, Vlaskamp C. Understanding low levels of physical activity in people with intellectual disabilities: a systematic review to identify barriers and facilitators. *Res Dev Disabil*. 2017;68:95-110. doi:10.1016/j.ridd.2017.06.008
23. Rimmer JH, Rowland JL, Yamaki K. Obesity and secondary conditions in adolescents with disabilities: addressing the needs of an underserved population. *J Adolesc Health*. 2007;41:224-229.
24. Smith E, Stogios N, Au E, et al. The metabolic adverse effects of antipsychotic use in individuals with intellectual and/or developmental disability: a systematic review and meta-analysis. *Acta Psychiatr Scand*. 2022;146(3):201-214. doi:10.1111/acps.13484
25. Taggart L, Coates V, Truesdale-Kennedy M. Management and quality indicators of diabetes mellitus in people with intellectual disabilities. *J Intellect Disabil Res*. 2013;57(12):1152-1163. doi:10.1111/j.1365-2788.2012.01633.x
26. Uusitupa M, Khan TA, Viguiliouk E, et al. Prevention of type 2 diabetes by lifestyle changes: a systematic review and meta-analysis. *Nutrients*. 2019;11(11):2611. doi:10.3390/nu11112611
27. Maine A, Brown MJ, Dickson A, Truesdale M. An evaluation of mainstream type 2 diabetes educational programmes in relation to the needs of people with intellectual disabilities: a systematic review of the literature. *J Appl Res Intellect Disabil*. 2019;32(2):256-279. doi:10.1111/jar.12544
28. Brown M, Taggart L, Karatzias T, et al. Improving diabetes care for people with intellectual disabilities: a qualitative study exploring the perceptions and experiences of professionals in diabetes and intellectual disability services. *J Intellect Disabil Res*. 2017;61(5):435-449. doi:10.1111/jir.12369
29. Lloyd M, Temple VA, Foley JT, et al. Young adults with intellectual and developmental disabilities who participate in Special Olympics are less likely to be diagnosed with depression. *Soc Psychiatry Psychiatr Epidemiol*. 2023;58(11):1699-1708.
30. Special Olympics. *Our Work: Healthy Athletes*. Accessed 22 July 2020 https://www.specialolympics.org/our-work/inclusive-health/healthy-athletes
31. Davies T, Wiens L, Trono C, Wilson A. *Long-term Athlete Development: Supporting Quality Sport Experiences 2.0*. 2021 https://www.specialolympics.ca/sites/default/files/SO-LTAD2_EN_FINAL_WEB.pdf
32. Ryan J, McCallion P, McCarron M, Luus R, Burke E. Overweight/obesity and chronic health conditions in older people with intellectual disability in Ireland. *J Intellect Disabil Res*. 2021;65(12):1097-1109. doi:10.1111/jir.12900
33. Tint A, Thomson K, Weiss JA. A systematic literature review of the physical and psychosocial correlates of Special Olympics participation among individuals with intellectual disability. *J Intellect Disabil Res*. 2017;61(4):301-324. doi:10.1111/jir.12295
34. Bondár RZ, Fronso S, Bortoli L, Robazza C, Metsios GS, Bertollo M. The effects of physical activity or sport-based interventions

14645491, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/dme.15393 by Meghann Lloyd , Wiley Online Library on [25/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

on psychological factors in adults with intellectual disabilities: a systematic review. *J Intellect Disabil Res*. 2020;64(2):69-92. doi:10.1111/jir.12699
35. ICES. *ICES home page*. https://www.ices.on.ca/
36. de Oliveira C, Gatov E, Rosella L, et al. Describing the linkage between administrative social assistance and health care databases in Ontario, Canada. *Int J Popul Data Sci*. 2022;7(1):1689. doi:10.23889/ijpds.v7i1.1689
37. Lin E, Balogh R, Cobigo V, Ouellette-Kuntz H, Wilton AS, Lunsky Y. Using administrative health data to identify individuals with intellectual and developmental disabilities: a comparison of algorithms. *J Intellect Disabil Res*. 2013;57(5):462-477.
38. Lipscombe LL, Hwee J, Webster L, Shah BR, Booth GL, Tu K. Identifying diabetes cases from administrative data: a population-based validation study. *BMC Health Serv Res*. 2018;18:1-8. doi:10.1186/s12913-018-3148-0
39. Statistics Canada. Postal Code OM Conversion File. https://www150.statcan.gc.ca/n1/en/catalogue/92-154-X
40. Reid RJ, Bogdanovic B, Roos NP, Black C, MacWilliam L, Winnipeg MV. *Do some physician groups see sicker patients than others? Implications for primary care policy in Manitoba*. 2001.
41. Manitoba Centre for Health Policy. *Adjusted Clinical Groups® (ACG®)—Overview*. University of Manitoba. Accessed August 23, 2018, 2018. http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?conceptID=1304
42. Manitoba Centre for Health Policy Evaluation, Reid RJ. Measuring morbidity in populations: performance of the Johns Hopkins adjusted clinical group (ACG) case-mix adjustment system in Manitoba. *Citeseer*. 1999.
43. Clark AM. What are the components of complex interventions in healthcare? Theorizing approaches to parts, powers and the whole intervention. *Soc Sci Med*. 2013;93:185-193. doi:10.1016/j.socscimed.2012.03.035
44. Harada CM, Siperstein GN. The sport experience of athletes with intellectual disabilities: a national survey of Special Olympics athletes and their families. *Adapt Phys Activ Q*. 2009;26(1):68-85.
45. Mobasseri M, Shirmohammadi M, Amiri T, Vahed N, Fard HH, Ghojazadeh M. Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis. *Health Promot Perspect*. 2020;10(2):98-115. doi:10.34172/hpp.2020.18
46. Leslie RD, Evans-Molina C, Freund-Brown J, et al. Adult-onset type 1 diabetes: current understanding and challenges. *Diabetes Care*. 2021;44(11):2449-2456. doi:10.2337/dc21-0770
47. Chen L, Magliano DJ, Zimmet PZ. The worldwide epidemiology of type 2 diabetes mellitus—present and future perspectives. *Nat Rev Endocrinol*. 2012;8(4):228-236. doi:10.1038/nrendo.2011.183
48. World Health Organization. *Global Status Report on Physical Activity 2022*. World Health Organization; 2022.
49. Katzmarzyk PT, Friedenreich C, Shiroma EJ, Lee I-M. Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. *Br J Sports Med*. 2022;56(2):101-106. doi:10.1136/bjsports-2020-103640
50. Ding D, Lawson KD, Kolbe-Alexander TL, et al. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. *The Lancet*. 2016;388(10051):1311-1324. doi:10.1016/S0140-6736(16)30383-X
51. Barbosa A, Whiting S, Ding D, Brito J, Mendes R. Economic evaluation of physical activity interventions for type 2 diabetes management: a systematic review. *Eur J Public Health*. 2022;32:i56-i66. doi:10.1093/eurpub/ckac074

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