A prospective comparison of the AUSDRISK and HbA1c for persons with spinal cord injury

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KEYWORDS

AUSDRISK, type 2 diabetes, spinal cord injury, diabetes screening tools, preventative health

ABSTRACT

Objective
The primary object of this study was to determine the validity of the Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK) for predicting the development of type 2 diabetes in persons with spinal cord injury (SCI).

Design and setting
The prospective comparative study (December 2013-March 2014) collected data on AUSDRISK and haemoglobin A1c (HbA1c) in participants' homes.

Participants
Participation rate was 67% (n=79). Study criteria: over 18 years of age, a SCI for more than 12 months, living at home, wheelchair dependant and no diabetes diagnosis.

Main outcome measures
AUSDRISK sensitivity and specificity in predicting incident type 2 diabetes in persons with SCI.

Results
Of the 79 participants, 81% were male, mean age was 53 years (SD 14.14) with 23.2years (median 23; SD +/- 13.2yrs) since injury. There was a positive correlation between length of time since SCI and risk score (AUSDRISK) ($r = .242$, $p = .032$). Participants with high AUSDRISK scores had higher HbA1c% (5.38 versus 5.2, $p = .026$) level. The high risk classification explained a moderate amount of HbA1c % (area under curve = .651; 95% CI .53 - .77). The level of HbA1c which had the highest sensitivity (.59) and specificity (.73) for risk classification was 5.25%. Waist circumference and physical activity items require further powered studies to determine if appropriately weighted.

Conclusion
Comparing the AUSDRISK with HbA1c assays, the AUSDRISK can predict type 2 diabetes risk in a person with SCI, although further powered studies are needed to be undertaken, to refine the predictive capacity of the tool.

INTRODUCTION

More than one million Australians are diagnosed with diabetes, the majority of whom (84.9%) have type 2 diabetes (Australian Institute of Health and Welfare 2012; Diabetes Australia and The Royal College of General Practitioners 2011). This proportion is escalating. With 275 people being diagnosed with type 2 diabetes every day it is anticipated that 3.3 million Australians will be living with the disease by 2031(Vos et al 2004).

Persons with spinal cord injury (SCI) are at higher risk for type 2 diabetes than the general population, primarily due to abnormalities of carbohydrate and lipid metabolism disorders common among persons with SCI (Raymond et al 2010; Banerjea et al 2008; LaVela et al 2006; Bauman and Spungen 2001). It has been demonstrated that SCI is independently associated with 2-fold increased odds of type 2 diabetes not explained by known risk factors for the disorder (Cragg et al 2015).

Due to adverse changes in body composition, metabolic rate and autonomic function, all known as consequences of SCI, physical health and functional ageing changes occur earlier in this population (LaVela et al 2012; Charlifue et al 2010; Banerjea et al 2008; Bauman and Spungen 2001; Soden et al 2000). Hence, early identification of type 2 diabetes is essential to limit associated microvascular and macrovascular complications (LaVela et al 2012; Gore and McGuire 2009; Middleton et al 2008; World Health Organisation and International Diabetic Federation 2006).

The Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK), based on nine risk factors was developed for predicting incident diabetes and promoted across the nation in 2008 (Chen et al 2010; Australian Government Department of Health and Ageing and Baker IDI Heart and Diabetes Institute 2009). The survey tool provides a simple way to classify adults as low, intermediate or high risk of developing diabetes (Chen et al 2010). Australian general practitioners have been encouraged to use AUSDRISK for patients who are at risk of developing diabetes; however awareness and application in general practice is low (Wong et al 2011). Individuals who are classified as high risk on the tool are recommended to be tested for diabetes (Colagiuri et al 2009).

The AUSDRISK has been validated for the population as a whole (Chen et al 2010), with limited testing in population subgroups (Fernandez and Frost 2013; Sathish et al 2013; Pasco et al 2010). When compared to multiple other risk assessment methods in a rural Asian population, the AUSDRISK performed equal to most other tools in predicting risk of diabetes, dysglycaemia and metabolic syndrome (Sathish et al 2013). To date there is no published evidence that the AUSDRISK has been used on persons with SCI to predict incident diabetes. Therefore, the primary aim of this study was to determine the validity of the AUSDRISK for predicting the development of type 2 diabetes in persons with SCI.

METHODS

This was a prospective comparative study set in one of Sydney's metropolitan local health districts. Data were collected between December 2013 and March 2014 using convenience sampling. Participants were identified using a university tertiary hospital database. From the database there were 118 people identified as eligible for the study. Persons were eligible if they were residents of the local health district, older than 18 years of age, had sustained a SCI for more than 12 months, lived at home, were wheelchair dependent and had not been diagnosed with diabetes. All 118 persons were mailed an information sheet and invited to contact the lead investigator.

Data were collected at participants' homes by the principal author. Data included: AUSDRISK screening tool, a haemoglobin A1c (HbA1c) assay and an eight item interview tool, based on available literature, was

developed by the authors. AUSDRISK items relate to risk factors including: age, gender, ethnicity/country of birth, antihypertensive medication usage, smoking, waist measurement, physical activity level, familial history of diabetes, fruit and vegetable intake and high blood glucose history. Each answer was scored and the sum total classified the participant as low risk (less than 5 points), intermediate risk (between 6-11 points) or high risk (more than 12 points) of developing diabetes. The interview tool questions included the classification of the neurological level and severity of the each injury according to the American Spinal Injury Association (ASIA) Impairment Scale (AIS) and recorded the individuals' weight, vital signs, and general practitioner contact details. During the home visit, to support health promotion, all participants were offered diabetes education and resource material.

To measure the HbA1c, Point of Care Diagnostics sponsored the loan blood analyser (Afinion AS100™). The company manager trained the principal author in the use of the equipment. A HbA1c assay was obtained using a small capillary lancet finger prick of 1.5 µ which took three minutes to analyse. Infection control precautions were adhered to throughout the procedure. The point of care analysing device was quality tested each month (externally) to confirm reliability and validity. For the purposes of this study, a level of HbA1c 6.0% was considered the cut-off point for high risk of the presence of diabetes.

The data were analysed using IBM SPSS program (IBM SPSS v.21, Chicago IL USA). Data were summarised using frequencies, percentages, means and standard deviations. Associations between continuous score and variables and HbA1c were conducted using Pearsons or Spearman's r correlation and characteristics. Associations between categorical variables and HbA1c were conducted using Pearsons Chi-Square (X^2) test. Receiver Operating Characteristics (ROC) was used to assess sensitivity and specificity of the AUSDRISK tool and HbA1c. Statistical significance was considered met at p=0.05 and 95% confidence interval.

The study was approved by the local Human Research Ethics Committee (HREC 1305-160M) and operated according to the guidelines of the National Health and Medical Research Council of Australia.

FINDINGS

From the 118 mailed invitations, 24 were 'returned to sender', eight persons had diagnosis of diabetes, and seven declined participation. The participation rate was 66.9% (n=79). Of the 79 participants, 81% were male and the mean age was 53 years (SD 14.14) (table 1). The mean number of years since injury was 23.2years (median 23; SD +/- 13.2yrs). The most common (58%) neurological levels of SCI were within the cervical region and almost two-thirds (65.8%) of all the participants were graded as AIS A (complete injury).

The most frequent risk factors identified were insufficient exercise (58.2%) and taking anti-hypertensive medication (21.5%). The average waist circumference was 112.1cm; with males having an average waist circumference of 113.4cm compared to 106cm for females. Sixty-four (81%) participants had the maximum point score available for waist circumference. There was no statistical difference when comparing waist measurement with gender (X^2 p=.402).

There was also no difference in the predicted risk of diabetes or the presence of diabetes (HbA1c % and mmol/mol) according to the extent of the neurological deficit arising from the SCI (table 2).

Table 1: Participant Characteristics (n = 79)

Characteristic	N	%
Age (years, mean, SD)	53	14.14
Male	64	81
Females	15	19
Ethnicity		
Australian born	74	93.6
Born outside Australia	3	3.7
Pacific Islander	2	2.5
Level of spinal cord injury		
Tetraplegia (C3-8)[a]	44	55.7
High paraplegia (T1-T6)[b]	14	17.7
Low paraplegia (T7-L2)[c]	21	26.6
Completeness of spinal cord injury		
AIS[d]-A (Complete)	52	65.8
AIS-B and C (Incomplete)	27	34.1
Risk factors for diabetes		
Family history of diabetes	9	11.3
History of hyperglycaemia	7	8.9
Antihypertensive medications	17	21.5
Current smoker	7	8.9
Insufficient daily intake of fruit and vegetables	15	18
Insufficient exercise of < 150 mins/week	46	58.2
Waist circumference (cms, mean, SD)	112.1	19.9
Weight (kgs, mean, SD)	82.5	18.4

a Cervical neurological injury
b Thoracic neurological injury
c Lumbar neurological injury
d American Spinal Injury Association Impairment Scale: A B C

Table 2: Classification of risk of diabetes (AUSDRISK) for spinal cord injury deficit

Characteristic	Overall		Complete AIS A (n = 52)		Incomplete AIS B/C (n = 27)		P value*
	N or mean	% or SD	N or mean	% or SD	N or mean	% or SD	
AUSDRISK score	***14.7***	***5.3***	***14.67***	***4.57***	***14.78***	***6.59***	***.93***
Low risk <5	7	8.9	3	6	4	15	.34
Intermediate	19	24	14	27	5	19	
Between 6-11							
High risk ≥ 12	53	67.1	35	67	18	66	
HbA1c %	5.3	3.3	5.28	.33	5.39	.35	.16
HbA1c mmol/mol	34.42	3.68	33.98	3.58	35.26	3.80	.14

*t-test, chi-squared or Fishers' exact test used

There was a positive and statistically significant correlation between length of time since SCI and risk score (AUSDRISK) (r = .242, p = .032) but not with HbA1c% (r = -.004, p = .97) or mmol/mol (r = -.041, p = .72). There were trends towards a correlation between risk score and HbA1c % (r = .210, p = .063) and mmol/mol (r = .215, p = .058).

The AUSDRISK classified 53 (67%) participants as high risk of developing diabetes, having a score greater than 12 points. These participants also had higher levels of HbA1c% (5.38 versus 5.2, p = .026) and higher HbA1c mmol/mol (35.08 versus 33.08, p = .022) (table 3). Two (2.5%) participants had HbA1c of 6% or above.

Table 3. Comparison of HbA1c % and mmol/mol for risk classification (AUSDRISK)

Characteristic	AUSDRISK low/intermediate < 12 points (n = 26)		AUSDRISK high ≥ 12 points (n = 53)		P level*
	Mean	SD	Mean	SD	
HbA1c %	5.2	.21	5.38	.37	.026
HbA1c mmol/mol	33.08	2.13	35.08	4.10	.022

*T-test

The high risk AUSDRISK classification explained a moderate amount of HbA1c % (area under curve = .651; 95% CI .53 - .77) (figure 1). The level of HbA1c, which had the high risk classification with the highest sensitivity (.59) and specificity (.73) was 5.25%.

Figure 2: Receiver operating curve for HbA1c mmol/mol versus high riskclassification on AUSDRISK

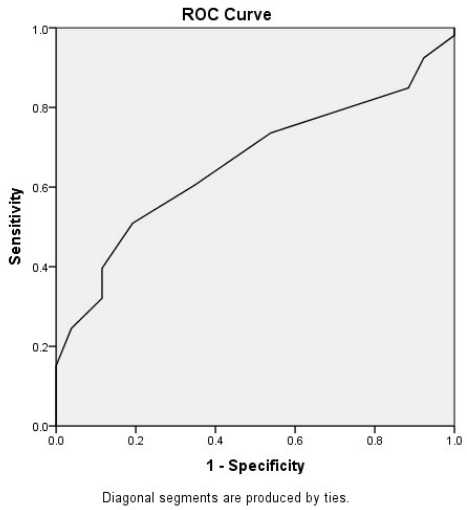
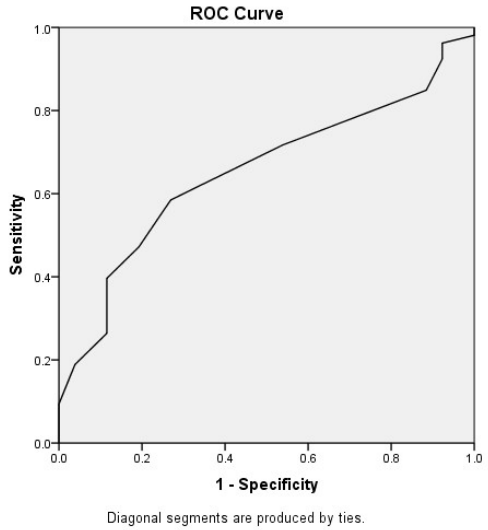


Figure 1: Receiver operating curve for HbA1c percent versus high risk classification on AUSDRISK



Similar results occurred for HbA1c mmol/mol as the AUSDRISK high risk classification explained a moderate amount of HbA1 mmol/mol (area under curve = .66; 95% CI .54 - .78) (figure 2). The level of HbA1c mmol/mol which had the highest sensitivity (.60) and specificity (.65) for high risk classification was 33.50 mmol/ mol. AROC analysis identified a moderate correlation with HbA1c and a high AUSDRISK score.

There were limitations to this study. The hospital database was reliant on all fields being up to date. However, addresses may have been incorrect reducing the potential sample size. As a result, the study may have underestimated the number of eligible people residing within the local health district. This was not a powered study and so sample size limits the generalisability. For the purposes of this study, medical screening for pre-existing conditions (e.g. abnormalities of red blood cell structure) known to interfere with HbA1c blood analysis were not undertaken, and may have influenced the findings. Future powered studies need to be conducted to determine the validity of the AUSRISK tool for people with SCI.

DISCUSSION

The AUSDRISK is a useful screening tool for predicting incident diabetes in the SCI population. The discriminatory ability of the AUSRISK was moderate when compared with HbA1c. There was a positive correlation between length of time since injury and diabetes risk. Diabetes rates are likely to increase in the SCI population given the improvement in life expectancy and anthropometric and physiologic changes associated with ageing with a SCI (Charlifue et al 2010; Banerjea et al 2008). Given the strong association between SCI and type 2 diabetes (Cragg et al 2015), there is an urgent need to monitor diabetes risk factors in this vulnerable patient group. The AUSDRISK can provide a dual function firstly by identifying type 2 diabetes risk factors, while providing an opportunity for health promotion and education. AUSDRISK screening should begin in the acute setting and continue in the primary health care setting. Further research needs to explore the screening frequency rate of AUSDRISK in the SCI population.

Due to the AUSDRISK high risk classifications, the AROC findings suggested the HbA1c threshold should be lowered to 5.25% (33.5mmol/mol) in a SCI cohort. This is in contrast to evidence that a HbA1c level of 6.0%-6.4% (42-47mmol/mol) should be recognised as high risk for the presence of diabetes (International Expert Committee 2009) or a HbA1c of 6.5% (48mmol/mol) being diagnostic of diabetes (World Health Organization 2011) in the normal population. Further powered studies need to be conducted to validate HbA1c sensitivity and specificity levels for persons with SCI.

This study identified that 21.5% of participants were on antihypertensive medication. Persons with a SCI level, which results in high paraplegia or tetraplegia, experience hypotension due to their blood pressure control being impaired, leading to lower resting blood pressures (Middleton et al 2008). This study supports the recent findings by Cragg et al (2015) that with improved treatment resulting in longevity that many are now having to be managed for chronic cardiovascular disease.

This study sample identified the majority had a large waist circumference, which supports the anatomical changes related to chronic SCI. The anatomical changes include: a decrease in muscle mass below injury level; weakened abdominal wall; a sunken chest; and, a lower positioned liver. Additionally chronic SCI results in an increase in visceral fat (Cragg et al 2015) and an enlarged colon. This study is the first to test the AUSDRISK in a SCI population, hence the AUSDRISK has only been validated in populations able to stand for waist circumference measurement. However, for persons who are wheel chair dependant and cannot weight bear, waist circumference often needs to be measured when seated or in supine position. Therefore, research is needed to validate the optimal waist circumference assessment method and scoring system for persons with SCI who are wheelchair dependant.

The AUSDRISK also scores a physical activity item. People need to undertake regular and sufficient exercise to improve insulin sensitivity. It has been identified that physical activity is a greater determinant of glucose concentration than neurological lesion level (Raymond et al 2010). For a person with SCI exercising may be a challenge and was reflected in the findings of these results. The AUSDRISK scoring system for physical activity needs further validation to determine whether adjusted scores for the SCI population are needed.

The AUSDRISK also scores 'ethnicity/country of birth'. This item (Australian born, Aboriginal, Torres Strait Islander, Pacific Islander, Maori descent, Asian, Middle Eastern, North African, Southern European) may need to be further explored to determine what the meaning of 'Australian born' is in a multicultural society. A better definition of 'Australian born' is required to ensure that scores are appropriately weighted to identify risk in all ethnically diverse sub-populations. This may be an important factor in determining diabetes risk.

This study demonstrated that for primary healthcare providers, the use of screening tools and point of care testing equipment in the home has the potential to enhance the patient experience, and reduce the burden on sub-groups that are challenged in seeking traditional health care assessments. Further studies need to be conducted with portable point of care technologies to improve the detection of preventable diseases within the Australian community.

CONCLUSION

This study provides evidence that when comparing the AUSDRISK risk classification to HbA1c assay, the tool can predict incident type 2 diabetes risk in persons with a SCI. The discriminatory ability of the AUSDRISK was moderate when compared with HbA1c. Further powered studies are needed to be undertaken to refine the predictive capacity of the tool and the frequency rate for screening. Utilising the AUSDRISK could prove useful as a screening tool and a health promotional opportunity to monitor and meet the ongoing health needs of people with SCI living in the community.

RECOMMENDATIONS

- AUSDRISK can be used to screen for type 2 diabetes in persons with SCI, although screening frequency rate requires further investigation.
- The HbA1c level for predictive risk of diabetes should be lowered in the spinal cord injured population.
- Further powered studies need to be undertaken to test the AUSDRISK tool to determine predictability for wheelchair dependent groups.
- The scoring for waist circumference and exercise activity items in the AUSDRISK tool require multi-centred powered studies to determine weighting for persons with SCI.

REFERENCES

Australian Government Department of Health and Ageing, Baker IDI Heart and Diabetes Institute. 2009. The Australian type 2 diabetes risk assessment tool (AUSRISK): how do you score? Australian Government Department of Health and Ageing, Canberra.

Australian Institute of Health and Welfare. 2012. Prevalence of diabetes. Commonwealth Government, Canberra.

Banerjea, R., Sambamoorthi, U., Weaver, F., Maney, M., Pogach, L., Findley, T. 2008. Risk of stroke, heart attack, and diabetes complications among veterans with spinal cord injury. *Archives of Physical Medicine & Rehabilitation,* 89(8):1448-1453.

Bauman, W. and Spungen, A. 2001. Carbohydrate and lipid metabolism in chronic spinal cord injury. *Journal of Spinal Cord Medicine,* 24(4):266-277.

Charlifue, S., Jha, A. and Lammertse, D. 2010. Aging with spinal cord injury. *Physical Medicine & Rehabilitation Clinics of North America,* 21(2):383-402.

Chen, L., Magliano, D., Balkau, B., Colagiuri, S., Zimmet, P., Tonkin, A., Mitchell, P., Phillips, P. and Shaw, J. 2010. AUSDRISK: an Australian Type 2 Diabetes Risk Assessment Tool based on demographic, lifestyle and simple anthropometric measures. *Medical Journal of Australia,* 192(5):274.

Colagiuri, S., Davies, D., Girgis, S. and Colagiuri, R. 2009. National evidence based guidelines for case detection and diagnosis of type 2 diabetes. NHMRC, Canberra.

Cragg, J., Ravensbergen, H., Borisoff, J. and Claydon, V. 2015. Optimal scaling of weight and waist circumferance to height for adipositity and cardiovascualr disease risk in individuals with spinal cord injury. *Spinal Cord,* 53(1):64-68.

Diabetes Australia, The Royal College of General Practitioners. 2011. Diabetes management in general practice: Guidelines for type 2 diabetes 2010/2011. The Royal College of General Practitioners, Melbourne.

Fernandez, R. and Frost, S. 2013. Congruence between the Indian Diabetes Risk Score and Australian Type 2 Diabetes Risk Assessment tool screening in Asian-Indians. *Nursing Research,* 21(2):36-39

Gore, M. and McGuire, D. 2009. The 10-year post-trial follow-up of the United Kingdom Prospective Diabetes Study (UKPDS): cardiovascular observations in context. *Diabetes and Vascular Disease Research,* 6(1):53-55.

International Expert Committee. 2009. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care,* 32(7):1327-1334.

LaVela, S., Evans, C., Prohaska, T., Miskevics, S., Ganesh, S. and Weaver, F. 2012. Males Aging With a Spinal Cord Injury: Prevalence of Cardiovascular and Metabolic Conditions. *Archives of Physical Medicine & Rehabilitation,* 93(1):90-95.

LaVela, S., Weaver, F., Goldstein, B., Chen, K., Miskevics, S., Rajan, S. and Gater, D. 2006. Diabetes mellitus in individuals with spinal cord injury or disorder. *Journal of Spinal Cord Medicine,* 29(4):387-395.

Middleton, J., Leong, G. and Mann, L. 2008. Management of spinal cord injury in general practice *Australian Family Physician,* 37(5):331-338.

Pasco, J., Kotowicz, M., Henry, M.J. and Nicholson, G. 2010. Evaluating AUSDRISK for predicting incident diabetes in an independent sample of women. *Medical Journal of Australia,* 193(1):374.

Raymond, J., Harmer, A., Temesi, J. and van Kemenade, C. 2010. Glucose tolerance and physical activity level in people with spinal cord injury. *Spinal Cord,* 48(8):591-596.

Sathish, T., Kannan, S., Sarma, S. and Thankappan, K. 2013. Screening Performance of Diabetes Risk Scores Among Asians and Whites in Rural Kerala, India *Preventing Chronic Disease* 10(E37):doi: 10.5888/pcd5810.120131.

Soden, R.J., Walsh, J., Middleton, J., Craven, M., Rutkowski, S. and Yeo, J. 2000. Causes of death after spinal cord injury. *Spinal Cord,* 38(10):604-610.

Vos, T., Goss, J., Begg, S. and Mann, N. 2004. Australian burden of disease and injury study, projected health care costs report. University of Queensland and Australian Institute of Health and Welfare.

Wong, K., Brown, A. and Li, S. 2011. AUSDRISK - application in general practice. *Australian Family Physician,* 40(7):524-526.

World Health Organization. 2011. Use of Glycated Haemoglobin (HbA1c) in the Diagnosis of Diabetes Mellitus. World Health Organization, Geneva.

World Health Organization, International Diabetic Federation. 2006. Definition and diagnosis of diabetes mellitus and intermediate hyperglycaemia. World Health Organization, Geneva.

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