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Does Arterial Stiffness Predict Cardiovascular Disease in Older Adults With an Intellectual Disability?

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Background: Arterial stiffness has been associated with an increased risk of cardiovascular disease (CVD) in some patient populations. **Objectives:** The aims of this study were to investigate (1) whether there is an association between arterial stiffness, as measured by the Mobil-O-Graph, and risk for CVD in a population of individuals with intellectual disability and (2) whether arterial stiffness can predict the risk for CVD. **Methods:** This cross-sectional study included 58 individuals who participated in wave 4 of the Intellectual Disability Supplement to the Irish Longitudinal Study on Aging (2019–2020). Statistical models were used to address the first aim, whereas machine learning models were used to improve the accuracy of risk predictions in the second aim. **Results:** Sample characteristics were mean (SD) age of 60.69 (10.48) years, women (62.1%), mild/moderate level of intellectual disability (91.4%), living in community group homes (53.4%), overweight/obese (84.5%), high cholesterol (46.6%), alcohol consumption (48.3%), hypertension (25.9%), diabetes (17.24%), and smokers (3.4%). Mean (SD) pulse wave velocity (arterial stiffness measured by Mobil-O-Graph) was 8.776 (1.6) m/s. Cardiovascular disease risk categories, calculated using SCORE2, were low-to-moderate risk (44.8%), high risk (46.6%), and very high risk (8.6%). Using proportional odds logistic regression, significant associations were found between arterial stiffness, diabetes diagnosis, and CVD risk SCORE2 ($P < .001$). We also found the Mobil-O-Graph can predict risk of CVD, with prediction accuracy of the proportional odds logistic regression model approximately 60.12% (SE, 3.2%). Machine learning models, *k*-nearest neighbor, and random forest improved model predictions over and above proportional odds logistic regression at 75.85% and 77.7%, respectively. **Conclusions:** Arterial stiffness, as measured by the noninvasive Mobil-O-Graph, can be used to predict risk of CVD in individuals with intellectual disabilities.

KEY WORDS: cardiovascular diseases*/prevention & control, heart disease risk factors, machine learning intellectual disability

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Cardiovascular diseases (CVDs) are a major contributor to mortality and morbidity across the globe, with myocardial infarction and stroke causing 85% of deaths related to CVD.[1] Whereas CVD mortality has decreased marginally over the past number of years, morbidity from CVD has increased. Most CVDs are preventable, because many of their risk factors such as hypertension, smoking, diabetes, obesity, physical inactivity, hyperlipidemia, and alcohol consumption are modifiable. Risk assessment and prediction help clinicians to identify high-risk patients in order that they obtain maximum benefit from prescribed preventive interventions and from instituting behavioral change. Therefore, risk assessment and risk prediction remain the cornerstone of CVD guidelines for practice.[2]

Several studies have shown that the prevalence of cardiovascular risk factors and diseases is similar in the general and intellectual disability populations, yet underdiagnosis is a common problem in people with an intellectual disability.[3–6] With increasing longevity and increased prevalence of some CVD risk factors such as obesity,[6–8] low levels of physical activity/sedentary behavior,[9] and diabetes,[10] individuals with intellectual disability seem at a high risk for CVD. This points toward a need to improve upon the ways in which clinicians assess cardiovascular health and screen for risk in those with intellectual disabilities.

There are many CVD risk-screening algorithms that objectively quantify an individual's risk, such as Framingham, QRESEARCH cardiovascular risk algorithm, and the recently updated Systematic COronary Risk Evaluation algorithm (SCORE2 and SCORE2-Older Persons). All algorithms require similar data to estimate risk, such as age, sex, smoking habits, and systolic blood pressure and cholesterol levels. Most perform similarly in terms of discrimination, provided they are applied to the appropriate population.[11]

In addition to these measures, studies have shown arterial stiffness, which reflects the rigidity of the arterial wall and is measured by aortic pulse wave velocity (PWV), to be a strong predictor of cardiovascular events as well as CVD.[7,12–15] In addition, arterial stiffness has been associated with mortality, although not limited to those deaths cardiovascular in nature.[7,14,15] In these studies, various instruments were used to measure PWV, such as oscillometric devices,[12] the Pulse Trace device,[14] the Complior device,[13] the applanation tonometry,[15] or a variety of modalities.[7] The Mobil-O-Graph is an oscillometric device, which has been shown to produce aortic PWV measurements comparable with the more invasive intra-aortic catheter measurements[16] and cardiac magnetic resonance.[17] However, the choice of instrument may depend on the cost and availability of specialized equipment and trained personnel, along with the population under investigation. The Mobil-O-Graph is suitable for use in individuals with an intellectual disability because it is noninvasive[7] and quick and easy to use.[18] These features make it amenable for use in individuals with attentional difficulties, whereas its portability facilitates its use in familiar/nonthreatening settings.

Assessing arterial stiffness using the Mobil-O-Graph in individuals with intellectual disability may help to address the problem of underdiagnosis of CVD risk in clinical practice. Although the relationship between arterial stiffness and risk for CVDs has been explored in the general population,[12,13] it has not yet been reported in those with intellectual disability. In this study, the authors investigate whether there is an association between arterial stiffness, as measured by the Mobil-O-Graph, and risk for CVD in a population of individuals with intellectual disability. They also investigate whether arterial stiffness, as measured by the Mobil-O-Graph, can predict risk for CVD. Statistical models are used to address the first aim, whereas machine learning models are used to improve the accuracy of risk predictions in the second aim.

Methods

Design and Study Sample

This cross-sectional study was carried out in 2020, as part of wave 4 of the Intellectual Disability Supplement to the Irish Longitudinal Study on Aging (IDS-TILDA), a longitudinal study of adults, 40 years and older, with an intellectual disability in Ireland. The IDS-TILDA sample was drawn from the National Intellectual Disability Database, which collects information on all people with an intellectual disability in the Republic of Ireland who are eligible for or receiving services.[19,20] Details of sampling methods used in earlier IDS-TILDA waves have been reported elsewhere.[21] The study is now over 10 years in existence, and as a number of participants had aged into the older age groups and a number had died (n = 172) or withdrawn (n = 75) from the study, it was decided to refresh the sample for wave 4. In total, 233 new participants were recruited into wave 4, bringing the total participant rate to 739, indicating an overall response rate of 87.1%.[21]

Participants were eligible for inclusion in this study if they completed the IDS-TILDA self- or informant-report measures (preinterview questionnaire and computer-assisted personal interview) in addition to Mobil-O-Graph and cholesterol measurements at the IDS-TILDA health assessment. Details on the health assessment have previously been reported.[22]

Of the 739 individuals who took part in wave 4 of IDS-TILDA, 274 completed the objective health assessment, before it being terminated because of the COVID-19 pandemic. Of these, 134 completed Mobil-O-Graph, and 91 provided a blood drop sample for cholesterol, with 62 individuals providing both Mobil-O-Graph and cholesterol

data. Individuals with atherosclerotic CVD were excluded from analyses because of their high-risk status of a recurrent event. Therefore, the study sample is 58 participants (see Figure 1 for the flowchart).

Data Collection and Ethics

Accessible easy-to-read materials with full explanation supported informed consent. The data collection instruments and processes were validated in previous waves. Objective measurements were completed as per protocol, at sites familiar to participants. Ethical approval was obtained from the university and from each of the participating service providers.

Outcome Measures

Demographic and Clinical Profile

Demographic data included sex, age by group, level of intellectual disability (mild, moderate, severe/profound), and type of residence (independent/family, community group home, and residential care). The presence of CVD (angina, heart attack, open heart surgery, angioplasty/stent insertion, heart failure, stroke/transient ischemic attack) was based on reporting ever having had a doctor's diagnosis of these conditions or having undergone a related procedure. The presence of cardiovascular risk factors (hypertension, diabetes) was based on taking antihypertensive medication and/or using oral hypoglycemic medication/insulin as well as having a doctor's diagnosis of these conditions. Other cardiovascular risk factors such as smoking status (current smoker/previous smoker/never smoked), alcohol consumption, level of physical activity (International Physical Activity Questionnaire), diet (fair/poor/at least good), and type of diet were self-reported. Body mass index was derived from anthropometric measurements of weight and height, which were obtained during objective health assessment and aligned with the World Health Organization's classification of underweight (<18.5 m^2), normal weight (18.5–24.9 m^2), overweight (25–29.9 m^2), and obese (>30 kg/m^2). Central obesity was also measured objectively at health assessment by the research clinician using waist circumference measurements.

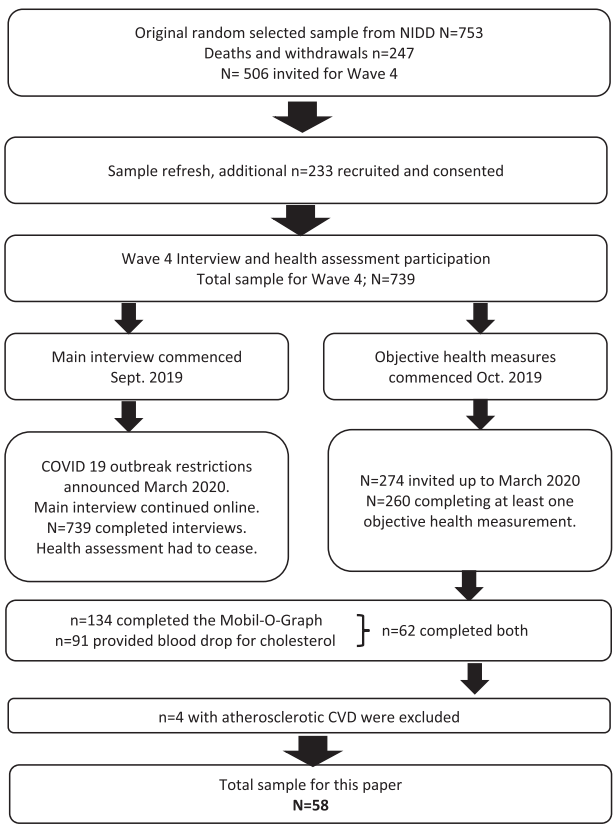

FIGURE 1. *Flowchart of study sample. CVD, cardiovascular disease; NIDD, National Intellectual Disability Database.*

Arterial Stiffness

Arterial stiffness was estimated using the Mobil-O-Graph device (PWA Monitor; IEM GmbH, Stolberg, Germany), a previously validated noninvasive oscillometric method, which provides values for PWV in meters per second.[16] During the single measurement, which was performed in a sitting, resting position, using the criteria for performing blood pressure,[23] other hemodynamic criterion standard measurements were obtained, such as central blood pressure, pulse pressure, and resting heart rate. Participants were shown the Mobil-O-Graph device, and it was explained how the accompanying cuff would be placed on their arm to obtain the measurement. They were informed how the cuff would feel while it was being inflated and the importance of remaining as still as possible while the device took its measurements. In addition, data on the individuals' age, sex, weight, height, and smoking status were recorded on the program software.

Cardiovascular Risk

To assess CVD risk, the SCORE2 risk-screening algorithm was used because it was considered suitable to this population, having been tested on large European data sets. Furthermore, it accounts for increasing longevity, up to 89 years, in the extended age SCORE2-Older Persons algorithm.[2] The SCORE2 algorithm estimates 10-year risk of fatal and nonfatal CVD events in apparently healthy participants without established atherosclerotic CVD, diabetes, and/or moderate-to-severe chronic kidney disease.[2] Risk estimations are displayed graphically in simple risk charts or can be accessed via a computer-based application. We used the chart because its format is useful for clinical practice. Ireland is considered a moderate-risk country[2]; therefore, we used the moderate-risk chart.

Predictive SCORE2 risk values were derived by applying each participant's sex, smoking status, age category, nearest systolic blood pressure, and non–high-density lipoprotein cholesterol to the chart. Objective

cholesterol levels were obtained through a capillary blood drop sample because this method was deemed less invasive than traditional venous blood sampling. Systolic blood pressure readings were taken from the Mobil-O-Graph outputs. All other data were self-reported and obtained from the computer-assisted personal interview.

As advancing age is a significant factor for CVD risk, CVD risk was categorized as low-to-moderate risk (green), high risk (yellow), and very high risk (red) in line with the European Society of Cardiology (2021)[2] suggestions for intensity of treatment by age. Individuals with atherosclerotic CVD were excluded from analyses because of their high-risk status for a recurrent event.[2] Participants who had diabetes were included separately in the model because they are at a higher risk than the general population.[2]

Data Analysis

SPSS version 26 was used for descriptive statistical analysis such as the demographic profile of the sample and the prevalence of CVD and cardiovascular risk factors. A proportional odds logistic regression model was used to examine the association between arterial stiffness, diabetes diagnoses, the participants' level of intellectual disability, etiology of intellectual disability, and residence type on CVD risk SCORE2. As SCORE2 is calculated using the variables age, sex, blood pressure, cholesterol level, and smoking status, these variables were not included as independent/predictor variables in the proportional odds logistic regression model. A reduced model of significant variables was examined to identify whether there was an association between arterial stiffness (represented by PWV), diabetes, and the 3 categories of risk for CVDs as defined by SCORE2.[2] The proportional odds logistic regression function from the MASS[24] "R" statistical package[25] was used to fit the model. Proportional odds logistic regression accounts for the fact that the dependent variable, CVD risk, is categorical with an inherent ordering. The proportional odds assumption of the proportional odds logistic regression model is a parallel regression model; that is, there are common coefficients for low-to-medium and medium-to-high CVD risk categories. The Brant test was used to test this assumption.[26] Akaike information criterion [27] was used for model selection. Akaike information criterion balances goodness of fit with the number of estimated parameters to avoid overfitting. The lower the Akaike information criterion, the better the model.[27]

Although statistical models are most suited to establishing the association between arterial stiffness and risk for CVD, they are not always the best approach for predictions. To find an optimal model for prediction of CVD risk, a machine learning approach was added because it can handle the nonlinearity relationship between risk factors and outcomes that has been purported to challenge conventional CVD risk prediction algorithms.[28] Proportional odds logistic regression was selected as the base model upon which to compare machine learning model outcomes. Prediction inferences were performed using random forest and *k*-nearest neighbor (kNN) classification algorithms. Hyperparameter tuning was performed for both models.

Random forest is a commonly used ensemble technique that combines individual predictions from multiple decision trees. Random forest takes the predictions from multiple decision trees into account, and the label most predicted by the decision trees is selected as the final prediction of the model. *k*-Nearest neighbor, on the other hand, is a model that uses most of the decisions made by the neighboring data points to make the prediction. This model, just like random forest, can be used for both regression and classification problems.

A *k*-fold approach was used for cross-validation whereby data were divided into 2 segments; one was used to train the model, whereas the other was used to validate/test the model.[29] The data were split into "*k*" folds/portions ($k = 5, 10, 15$) where "$k - 1$" folds of the data were used to train the model. During the model-fitting phase, one of the folds was kept aside to be used to validate the model. The models (proportional odds logistic regression, kNN, and random forest) were then used to predict the CVD risk SCORE2 category for the remaining test data. Lower *k*-fold values were selected to ensure sufficient test data were available for model validation and to check the accuracy of our predictions. This was repeated until all "*k*" folds of the data had been part of the test set. The prediction results from all "*k*" sets were averaged to provide the final prediction accuracy of the model. This complete process was repeated 100 times, whereby the data set was shuffled randomly such that both the training and test data were chosen in a different fashion each time. This provided an estimate of the variability of prediction accuracy.

Results

Demographic Profile, Prevalence of Cardiovascular Disease, and Risk Factors

The demographic profile of the sample (N = 58) along with the prevalence of cardiovascular risk factors is presented in Table 1. The mean age was 60.69 ± 10.48 (range, 41–87) years, and most participants were female (62.1%, n = 36/58). Most had a mild or moderate level of intellectual disability (91.4%, n = 53/58), and most lived in either community group homes (53.4%, n = 31/58) or residential care (25.9%, n = 15/58).

The prevalence of CVD in this cohort was very low; no individual had heart failure or angina. Four individuals with atherosclerotic CVD had previously been excluded. With respect to cardiovascular risk factors,

TABLE 1 Sample Characteristics of Adults With Intellectual Disability, 40 Years and Older (N = 58)

Characteristics		n	%	Mean ± SD (Range)
Age, y				60.69 ± 10.48 (41–87)
	<50	8	13.8	
	50–64	32	55.17	
	65+	18	31.03	
Gender	Male	22	37.9	
	Female	36	62.1	
Level of ID	Mild	23	39.7	
	Moderate	30	51.7	
	Severe/profound	5	8.6	
Cause of ID	Down syndrome	8	13.8	
	Other/unknown	50	86.2	
Type of residence	Independent/family	12	20.7	
	Community group home	31	53.4	
	Residential setting	15	25.9	
Other cardiovascular diseases (atherosclerotic excluded)	Angina/heart failure/abnormal heart rhythm	0	0	
Cardiovascular risk factors	Alcohol consumption	27	46.6	
	Almost every day	0	0	
	5 or 6 d/wk	0	0	
	Once/twice per week	9	33.3	
	Once/twice per month	5	18.5	
	Less than once per month	12	44.4	
	Not at all in the last 12 mo	1	3.7	
	High cholesterol	27	46.6	
	Hypertension	15	25.9	
	Diabetes	10	17.24	
	Current smoker	2	3.4	
Body mass index[a]				31.1 ± 5.8 (19.9–49.5)
	Normal weight	9	15.5	
	Overweight	17	29.3	
	Obese	32	55.2	
Waist circumference[a]				107.5 cm ± 12.6
	Male			108.1 cm ± 12.4
	Female			107.1 cm ± 12.9
Self-reported diet	Fair or poor	3	5.1	
	At least good	55	94.9	
Physical activity	Mild			
	Hardly ever or never	13	22.4	
	At least once a week	45	77.6	
	Moderate			
	Hardly ever or never	29	50.0	
	At least once a week	29	50.0	
	Vigorous			
	Hardly ever or never	52	89.7	
	At least once a week	6	10.3	
Arterial stiffness[a,b]				8.776 ± 1.6 (5.9–13.0)
	8.55[b] (IQR, 5.9–9.5)			
Central blood pressure[a]	Systolic			125.7 ± 18.0 (94–185)
	Diastolic			83.1 ± 10.5 (60–116)
Pulse pressure[a]				42.6 ± 16.6 (15–102)
Pulse[a]				71.5 ± 13.0 (44–108)

(continues)

TABLE 1 Sample Characteristics of Adults With Intellectual Disability, 40 Years and Older (N = 58), Continued

Characteristics		n	%	Mean ± SD (Range)
SCORE2 risk category[a]	Low-to-moderate CVD risk, total	26	44.8	
	• <50 y	6	10.3	
	• 50–69 y	19	32.8	
	• ≥70 y	1	1.7	
	High CVD risk, total	27	46.6	
	• <50 y	2	3.4	
	• 50–69 y	13	22.4	
	• ≥70 y	12	20.7	
	Very high CVD risk, total	5	8.6	
	• <50 y	0	0.0	
	• 50–69 y	0	0.0	
	• ≥70 y	5	8.6	

Abbreviations: CVD, cardiovascular disease; ID, intellectual disability; IQR, interquartile range.
[a]Objective measure.
[b]Median (interquartile range).

84.5% (n = 49/58) were overweight or obese, 46.6% had high cholesterol (n = 27/58), 25.9% (n = 15/58) had hypertension, 17.24% (n = 10/58) had diabetes, and 3.4% (n = 2/58) were smokers. Although 46.6% (n = 27/58) responded "yes" to drinking alcohol in the preceding year, no participant consumed alcohol more than once/twice a week (Table 1).

Most participants (94.8%, n = 55/58) reported their overall diet as being "at least good." Of the 23 participants who reported taking a special diet, approximately half were on low-fat (56.5%, n = 13) or weight-reducing (52.2%, n = 12) diets, whereas 17.4% (n = 4) were on a diabetic diet. Almost one-quarter (22.4%, n = 13/58) and half (50%, n = 29/58) of the participants reported hardly ever or never taking mild or moderate physical activity respectively, whereas 10.3% (n = 6/58) reported taking vigorous exercise at least once per week. The mean waist circumference was 107.5 ± 12.6 cm (108.1 ± 12.4 and 107.1 ± 12.9 cm in male and female participants, respectively). With respect to cardiovascular risk score, 44.8% (n = 26/58) were in the low- to moderate-risk group, 46.6% (n = 27/58) were in the high-risk group, and 8.6% (n = 5) were in the very high–risk group (Table 1).

The mean Mobil-O-Graph score provided measures for PWV as 8.776 ± 1.6 m/s. The mean systolic and diastolic central blood pressure measurements were 125.7 ± 18.0 and 83.1 ± 10.5 mm Hg, respectively, with a corresponding mean pulse pressure of 42.6 ± 16.6. The mean pulse rate of participants was 71.2 ± 13 (44–108) (Table 1).

Is Arterial Stiffness Associated With Cardiovascular Disease Risk SCORE2?

Using the proportional odds logistic regression model, significant associations were found between arterial stiffness (PWV), diabetes diagnoses, and CVD risk SCORE2 ($P < .01$). Results are displayed in Table 2. Reducing the model, to include only the significant variables, PWV and diabetes diagnoses produced the model fit displayed in Table 3, with odds ratio for arterial stiffness as exp(0.72) = 2.06 (95% confidence interval, 1.55–2.89). Thus, for every unit increase in PWV,

TABLE 2 Proportional Odds Logistic Regression: Model 1

Model 1 Coefficients	Coefficient Value	Odds Ratio	95% Confidence Interval
Diabetes indicator[a]	1.47	4.36	1.39–13.62
Down syndrome etiology	0.01	1.01	0.30–3.44
Residence type: community group home	0.07	1.08	0.37–3.17
Residence type: residential care	0.49	1.64	0.48–5.64
ID level: moderate	0.04	1.04	0.46–2.38
ID level: severe/profound	0.90	2.47	0.58–10.54
Mobil-O-Graph PWV reading[b]	0.77	2.15	1.53–3.02
Intercepts[b]			
SCORE2 risk category: low-to-moderate/high risk[b]	6.85		
SCORE2 risk category: high/very high risk[b]	9.75		

Measures of model fit: Akaike information criterion = 82.40.
Abbreviations: ID: intellectual disability; PWV, pulse wave velocity.
[a]Significant at $\alpha = .05$.
[b]Significant at $\alpha = .01$.

TABLE 3 Proportional Odds Logistic Regression: Model 2

Model 2 Coefficients	Value	Odds Ratio	Confidence Interval
Diabetes indicator[a]	1.30	3.68	1.36–11.29
Mobil-O-Graph PWV reading[b]	0.72	2.06	1.55–2.89
Intercepts[b]			
SCORE2 risk category: low-to-moderate/high risk	6.23		
SCORE2 risk category: high/very high risk[b]	8.93		

Measures of model fit: Akaike information criterion = 76.13.
Abbreviation: PWV: pulse wave velocity.
[a]Significant at $\alpha = .05$.
[b]Significant at $\alpha = .000$.

participants were twice as likely to be categorized as having a higher CVD risk. Moreover, a participant with a diabetes diagnosis was 3.5 times more likely (exp[1.30] = 3.68 [95% confidence interval, 1.36–11.29]) to belong to a higher risk category than a person with the same Mobil-O-Graph reading without diabetes. No evidence was found of a significant effect of level of intellectual disability, etiology of intellectual disability, or residence type on CVD risk SCORE2 ($P > .05$) based on this small sample of 58 participants.

Model 2 is a better model fit with Akaike information criterion of 76.13 (Table 3) compared with Akaike information criterion of 82.40 for model 1 (Table 2). The Brant test indicates that the proportional odds logistic regression assumption of a common slope across each of the CVD risk categories is reasonable ($P = .19 > \alpha$).

Can Arterial Stiffness Predict Risk for Cardiovascular Disease?

The proportional odds logistic regression model mentioned previously was explored to also address the second goal of this article: to enable the prediction of CVD risk SCORE2 given the participants' Mobil-O-Graph reading. Using a 5-fold (80% training data, n = 46; 20% test data, n = 12) cross-validation and 100 simulations of the prediction process, the prediction accuracy with the proportional odds logistic regression model was, on average, 60.12%, with a standard error of 3.2%.

Using machine learning models, we found that both kNN and random forest models improved model predictions over and above proportional odds logistic regression. However, the performance of random forest was slightly better than that of the kNN model. Of the selected *k*-fold values 5, 10, 15, and 100 simulations, *k*-fold = 5 (80% training data, n = 46; 20% test data, n = 12) produced the best result for the kNN model (mean [SD] accuracy, 75.85% [almost 0%]). Meanwhile, *k*-fold = 15 (93.3% training data, n = 54; 6.7% test data, n = 4) produced the best result for the random forest model (mean [SD] accuracy, 77.72% [1.61%]). As an example, Figure 2 shows the predictions of one of the 100 simulations for the random forest model. Data are denoted with orange points, whereas the blue circles indicate the predicted risk score category. Individuals with high PWV values (11, 12, 13) are mostly in the very high–risk score category (red), whereas those with the lower PWV values (6, 7, 8) are in the low-to-moderate risk (green) and so on.

Discussion

The demographic profile of our sample and the prevalence of cardiovascular risk factors such as hyperlipidemia (47%), hypertension (26%), and diabetes (17%) are broadly like other studies of individuals with intellectual disabilities internationally,[4,10] whereas measures such as blood pressure, pulse pressure, and pulse rate are similar to the general population.[2] In this study, more than half of our participants were in the high- or very high–risk SCORE2 category, which was no surprise, given their risk factors.

Early detection of CVD risk in addition to early intervention can halt disease progression, reduce medical costs, and prevent mortality.[30] Assessment of risk is at the core of primary prevention and should be used to guide decision making for preventive interventions. For instance, reducing weight and undertaking exercise concurrently can improve an individual's cardiovascular profile, reduce their blood pressure, improve glycemic control, and decrease the risk of type 2 diabetes.[2,31] To prompt preventive actions in implementing these

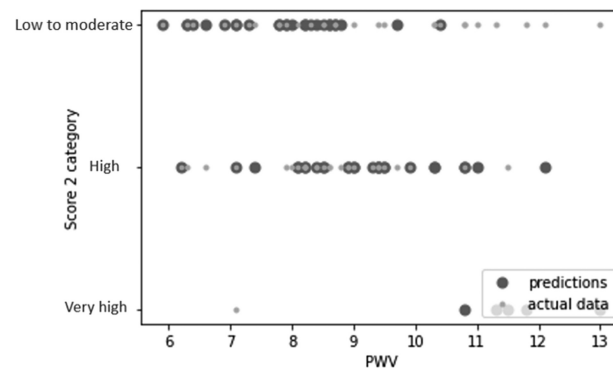

FIGURE 2. *An example of a plot of one of the 100 simulations for random forest. PWV, pulse wave velocity.*

interventions, individuals need to be aware of their risk status and the appropriate interventions to reduce these.[2] However, educating individuals with intellectual disabilities can be challenging, because their intellectual disability can affect their ability to understand complex health-related information, making it harder for them to learn about and follow through with recommendations for healthy lifestyle changes.[32] In addition, if they have mobility issues, it may be challenging for them to engage in physical activity.[33] Moreover, they may have difficulty accessing equipment/facilities suitable to their needs, or they may require extra support to participate in exercise programs,[33] further complicating efforts to lessen their CVD risk.

Current international guidelines recommend that all adults undertake at least 150 minutes of moderate-intensity (a minimum of 30 minutes per day 5 days per week) or 75 minutes of vigorous-intensity exercise, per week, along with a healthy diet and lifestyle.[2,31] These guidelines have also identified the inverse relationship between moderate/vigorous physical activity, cardiovascular events, and all-cause mortality. [2,31] Our study identified that half of our sample hardly ever or never undertook moderate-intensity physical activity, whereas almost 90% hardly ever or never undertook vigorous physical activity. Furthermore, most participants (85.5%) in our study were overweight or obese and had a mean waist circumference of 107.5 cm. Despite this, only one-quarter of participants reported being on a weight-reducing diet. Notwithstanding this, almost all reported their overall diet as being good, suggesting a lack of insight into the diet, exercise, and body mass index triad.

Researchers have written extensively about healthcare inequalities in adults with intellectual disabilities in comparison with the general population,[34,35] and addressing these inequalities has become a global priority.[36] The introduction of strategies such as annual primary care health checks for adults with intellectual disabilities have been somewhat successful in reducing but has not eliminated the inequalities gap.[34] For instance, in their large UK study, Hughes-McCormack and colleagues[34] (2020) used hard indicators of best practice to measure healthcare between 2007–2010 and 2014. Aspects of health promotion that remained poor for individuals with intellectual disabilities compared with the general population included lifestyle advice on increasing physical activity, smoking cessation, safe alcohol consumption, and healthy diet for patients with hypertension. In addition, significantly more patients from the general population were referred for further investigation after stroke/transient ischemic attack compared with those with an intellectual disability ($P < .001$). When the outcomes of the intellectual disability cohort were explored, separate to the general population, overall improvements were observed in 8 of the 12 conditions (including coronary heart disease, heart failure, stoke, diabetes, and hypertension) and in 19 of the 40 clinical indicators, demonstrating that improvements can be made.[34]

These findings should be considered in the context of health checks provided to older people with an intellectual disability. Identification and understanding of CVD risk and associated health promotion activities may provide a means of encouraging adherence to lifestyle or pharmacological therapies. Furthermore, it would enable healthcare providers to match the type and intensity of an intervention to the individual's risk, maximizing the potential benefit. However, health promotion interventions are a recently emerging field of research in individuals with intellectual disabilities. A systematic review[37] and a scoping review[38] evaluated interventions designed to encourage behavior change, among individuals with intellectual disabilities[37] and those with disability, living in supported accommodation.[38] Some programs were devised specifically for adults with intellectual disabilities, whereas others were adapted from programs initially developed for the general population.[37,38] Although evidence from both reviews suggest that behavior-focused health promotion programs can be effective for individuals with intellectual disabilities, a lack of heterogeneity in terms of study design, intervention characteristics, targeted outcomes, and methodological quality limits the ability to draw definitive conclusions around efficacy and the components of a good intervention.[37,38]

Nonetheless, as most interventions comprise education, greater involvement of caregivers, family members, partners, and friends is recommended as a worthwhile strategy.[32,37,38] Consistent with this, Vetter and colleagues[39] (2022), whose study included a secondary data analysis of 38 interviews with individuals who had mild-to-moderate intellectual disabilities, reported the significant impact interpersonal relationships can have in shaping an individual's understanding and knowledge of health-related information. On the basis of trust and emotional connection, these caregivers can also serve as resources, motivators, and supports, helping to reinforce the importance of healthy lifestyle choices and providing assistance with physical activity and other health-promoting behaviors. These results are further supported in a randomized controlled trial[40] that included adults with intellectual and developmental disability and their helpers (family members, carers) with greater improvements reported for those who had a helper. A novel aspect of this study[40] is that participants could choose their own helpers, implying that the relationship was already grounded on trust and emotional connection. Although these results underscore the importance of involving family members or carers in interventions for individuals with an intellectual disability, further research is required to determine

What's New and Important

- People with intellectual disabilities are at risk for CVDs, yet they are often marginalized in healthcare and research.
- Having a noninvasive, user-friendly risk assessment instrument that does not require access to laboratory samples would be particularly useful in assessing CVD risk in individuals with intellectual disability in primary care and residential settings.
- When high risk for CVD is identified in a timely manner, healthcare providers can proactively encourage lifestyle redesign and adherence to pharmacological therapies. This has the potential to reduce the burden of CVD.
- The use of machine learning techniques can strengthen statistical predictions.

what constitutes a "criterion standard" intervention for this cohort.

Consistent with CVD risk assessment, arterial stiffness measurements have become of increasing interest in the last decade. The mean PWV, as measured by the Mobil-O-Graph in this study, was 8.8 m/s, which is consistent with published reference values for the general population.[41] We also found that arterial stiffness was strongly associated with CVD risk using SCORE2 and that it was possible to predict CVD risk categories using SCORE 2 quite accurately using only Mobil-O-Graph readings. Consequently, our study supports using the Mobil-O-Graph in predicting CVD risk in individuals with an intellectual disability. This is an important finding, as having a risk assessment instrument that is noninvasive and user friendly and does not require or assume access to laboratory samples would be particularly useful in primary care and residential settings. The Mobil-O-Graph device resembles a blood pressure cuff; therefore, its familiarity would promote a sense of ease to its use and support engagement and empowerment in individuals with intellectual disability.

The results of this study were supported by machine learning, with a prediction accuracy of 78%. We found that machine learning models, kNN, and random forest improved model predictions over and above POLR; however, it is generally understood that no one algorithm is better than the other but is more related to the method used.[42] Akella and Akella[43] (2021) applied machine learning algorithms to the publicly available Cleveland data set, to predict the presence of coronary artery disease. Like our study, 2 of the models used were kNN and random forest. However, all 6 models used performed well and achieved accuracies greater than 80%, thus supporting the use of machine learning algorithms in detecting the presence of CVD. Suri and colleagues[28] (2022) computed the risk of bias for CVD risk prediction, in 39 studies that used machine learning (n = 24) and non–machine learning (n = 15). They found the bias effect in machine learning studies was 43% less compared with non–machine-learning studies, using the analytical slope method, further supporting the benefit of machine learning in improving the accuracy of CVD risk prediction.

The strengths and limitations of our study warrant consideration. Previously reported data within this population support this investigation. Overweight and obesity levels at 79.7%,[44] associated chronic health,[8] and high levels of sedentary behavior[9] all support and emphasize the need for primary prevention among this vulnerable cohort. All objective measures were carried out by the same 3 registered intellectual disability nurses who were trained to ensure consistent accurate administration and scoring of measures as per study protocol. Using the Mobil-O-Graph was acceptable to the participants in this study and presents an opportunity for this convenient but robust objective measure to be used within primary healthcare. However, past studies that used the Mobil-O-Graph to measure PWV have typically conducted 2 measurements and used the mean of both,[18,45] with limited instances of a single measurement being used.[46] Therefore, the use of only 1 measurement in this study can be considered a limitation. The sample size was small owing to COVID-19 restrictions terminating the health fair, which meant potential participants were precluded from completing the requisite objective measures. The sample was further limited in that it only comprised individual residents in Ireland. In addition, the small sample had implications for the number of cases available to train the model. Further studies with a larger sample size should provide more robust evidence. The study was cross-sectional, and therefore, clinical follow-up data with respect to the development of CVD were not available. However, the use of machine learning strengthened the predictions of the results.

Conclusion

Individuals with intellectual disabilities have many risk factors for CVD, yet they are often marginalized in healthcare and research. When high risk for CVD is identified in a timely manner, healthcare providers can proactively encourage lifestyle redesign and adherence to pharmacological therapies. Although further research is required regarding what constitutes a "criterion standard" intervention for this cohort, matching the intensity of the intervention to the level of risk, and involving family members/carers in the intervention, maximizes the benefit to the individual and has the potential to reduce the burden of CVD. Arterial stiffness, as measured by PWV using the Mobil-O-Graph, can be used to predict risk for CVD risk categories in individuals with an intellectual disability. The Mobil-O-Graph is suitable for use in this cohort

because it is noninvasive, portable, and easy to use, and does not require laboratory data. Assessing arterial stiffness in this way may help to address the problem of underdiagnosis of CVD risk in individuals with intellectual disability. However, the relationship between Mobil-O-Graph measurement, intervention, and subsequent outcomes should be tested in future research.

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