

How do multimorbidity and lifestyle factors impact the perceived health of adults with intellectual disabilities?

M. I. Olsen,^{1,2}  M. B. Halvorsen,³  E. Søndena, ^{4,5}  E. M. Langballe,^{6,7}  E. Bautz-Holter,⁸
E. Stensland,⁹ S. Tessem¹  & A. Anke^{1,2,8} 

¹ Department of Rehabilitation, University Hospital of North Norway, Tromsø, Norway

² Faculty of Health Sciences, Department of Clinical Medicine, UiT - The Arctic University of Norway, Tromsø, Norway

³ Department of Pediatric Rehabilitation, University Hospital of North Norway, Tromsø, Norway

⁴ Faculty of Medicine and Health Sciences (MH), Department of Mental Health, Norwegian University of Science and Technology, Trondheim, Norway

⁵ Department of Brøset, St. Olavs University Hospital, Trondheim, Norway

⁶ Norwegian National Advisory Unit on Ageing and Health, Vestfold Hospital Trust, Tønsberg, Norway

⁷ Department of Geriatric Medicine, Oslo University Hospital, Oslo, Norway

⁸ Institute of Health and Society, Research Centre for Habilitation and Rehabilitation Model and Services CHARM), Faculty of Medicine, University of Oslo, Oslo, Norway

⁹ Department of Community, Medicine, UiT - The Arctic University of Norway, Tromsø, Norway

Abstract

Background Adults with intellectual disability (ID) have poorer physical and perceived health than the general population. Knowledge of perceived health predictors is both limited and important for guiding the development of preventive actions. The aims of this study were to investigate (1) the associations between perceived health and demographics, degree of ID, physical health conditions, and weight and physical activity level and (2) lifestyle factors and multimorbidity as predictors for perceived health adjusted for age, gender, and level of ID.

Method The North Health in Intellectual Disability study is a community based cross-sectional survey. The POMONA-15 health indicators were used. Univariate and multivariate logistic regression analyses with poor versus good health as the dependent variable were applied.

Results The sample included 214 adults with a mean age 36.1 (SD 13.8) years; 56% were men, and 27% reported perceiving their health as poor. In univariate analyses, there were significant associations between poor health ratings and female gender, lower motor function, number of physical health conditions and several indicators of levels of physical activity. In the final adjusted model, female gender [odds ratio (OR) 2.4, $P < 0.05$], level of ID (OR 0.65, $P < 0.05$), numbers of physical health conditions (OR 1.6, $P < 0.001$) and lower motor function (OR 1.5 $P < 0.05$) were significant explanatory variables for poor perceived health, with a tendency to independently impact failure to achieve 30 min of physical activity daily (OR 2.0, $P = 0.07$).

Conclusion Adults with ID with female gender, reduced motor function and more physical health conditions are at increased risk of lower perceived health and should be given attention in health promoting interventions. A lack of physical activity tends to negatively influence perceived health.

Correspondence: Ms Monica Isabel Olsen, Department of Rehabilitation, University Hospital of North Norway, Sykehusveien 38, 9038 Tromsø, Norway (e-mail: monica.isabel.olsen@unn.no)

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Keywords intellectual disability, lifestyle, multimorbidity, perceived health, physical activity, physical health

Background

Population-based surveys have revealed that perceived health in adults with intellectual disability (ID) is below that of those without ID (Emerson *et al.* 2016; Kinnear *et al.* 2019). Furthermore, people with ID have poorer health status than the general population (van Schroyen Lantman-de Valk 2000; Haveman *et al.* 2011; Hermans and Evenhuis 2014). Multimorbidity, defined as having more than one simultaneous disease or medical condition [World Health Organization (WHO) 2016], is common in people with developmental disabilities including ID (Evenhuis *et al.* 2001; McMahon and Hatton 2020). Inadequate health promotion with higher prevalence of risk factors, such as obesity (Emerson *et al.* 2016; Kinnear *et al.* 2018) and lack of physical activity, has been associated with multimorbidity (Tyrer *et al.* 2019). However, knowledge of the associations between lifestyle factors and multimorbidity to general health ratings is limited.

In the general population, objective health status is consistent with self-rated health (Wu *et al.* 2013). Perceived health studies of those with ID are often reported by proxy responders (Emerson *et al.* 2016; Scott and Haverkamp 2018; Kinnear *et al.* 2019; Jin *et al.* 2020). Scott and Haverkamp (2018) concluded that self-health and caregiver-health reports were significantly related in individuals with ID, and both rating methods are in use (Kinnear *et al.* 2019; Jin *et al.* 2020).

The severity of ID is important for the occurrence of diseases and lifestyle. Individuals with severe or profound ID were found to have more comorbid diseases (Folch *et al.* 2018), and a higher risk of neurodevelopmental conditions than people with milder ID (van Schroyen Lantman-de Valk *et al.* 1997; Moreno-De-Luca *et al.* 2013). Van Timmeren *et al.* (2017) found a pattern of five prevalent physical health problems, which included visual impairment, constipation, epilepsy, spasticity and scoliosis, in individuals with severe or profound ID and motor disabilities (van Timmeren *et al.* 2017).

Some diseases, including cardiovascular diseases, cancer, pulmonary diseases and allergies, occur less frequently in the ID population compared with the general population (Cooper *et al.* 2015; Folch *et al.* 2018; McMahon and Hatton 2020). Reviews indicate that lower intellectual capacity is perceived as a limiting factor for being physically active (Dairo *et al.* 2016; Bossink *et al.* 2017) with consequences for health and mortality rates (Oppewal and Hilgenkamp 2019). Several studies report that severe or profound ID is associated with being underweight (Emerson 2005; Bhaumik *et al.* 2008; Hsieh *et al.* 2014), while milder ID has been identified as a risk factor for being overweight and obesity (de Winter *et al.* 2012; Folch *et al.* 2018; Ranjan *et al.* 2018). Concordantly, the evidence regarding the association between the severity of ID and poorer perceived health is conflicting (Jin *et al.* 2020).

The reported prevalence of perceived poor health in adults with ID varies between 22% in an Australian study (Cocks *et al.* 2017), and 40.2% in the United States (Jin *et al.* 2020), and 52% in the United Kingdom (Kinnear *et al.* 2019). The Australian study found increasing age, financial hardship and being physically inactive to be associated with 'not good' health (Cocks *et al.* 2017). Recently, Jin *et al.* (2020) found that obese adults had worse perceived health than those with normal weight and found significant negative impacts on perceived health from smoking and lack of moderate physical activity. However, medical health conditions or multimorbidity were not adjusted for in the multivariate analyses in previous publications on perceived health in adults with ID (Cocks *et al.* 2017; Bond *et al.* 2019; Kinnear *et al.* 2019; Jin *et al.* 2020). Accordingly, the objectives of the current study are to investigate in a community-based setting (1) the associations between perceived health and demographics, degree of ID, physical health conditions, and weight and physical activity level and (2) lifestyle factors and multimorbidity as predictors for perceived health adjusted for age, gender and level of ID.

Methods

Study design

The North Health in Intellectual Disability study is a cross-sectional multicentre study.

Setting and procedure

This study was led from the University Hospital of North Norway (UNN) in Tromsø in cooperation with the St. Olavs Hospital in Trondheim. Data were collected between October 2017 and December 2019 in the municipalities of Tromsø, Balsfjord, Narvik, Malvik and parts of Trondheim, which are situated in the north and middle of Norway. The recruitment and data collection in each municipality were performed by research assistants with a health professional background (research nurses, ID nurses and one physiotherapist). Regular meetings on Skype between all collaborators were held to clarify questions and secure quality in the data collection. A pilot study was done in 2016 to test out the feasibility of the study.

Potential participants were identified through (1) information available from the municipality (receiving services) (Søndenaa *et al.* 2010) or (2) specialised ID services. An invitation letter to the study was sent out to each eligible person registered in the specialised ID services records at the UNN and St. Olavs Hospital. The eligible person's next of kin or guardian was then contacted by telephone. After approximately 4 weeks, a reminder letter was sent out to those who did not respond. Eligible individuals who were not registered at the hospitals specialised ID services were directly contacted by employees of the municipalities by invitation letters and/or telephone. Administrative leaders of the services in the municipalities and the user organisations were informed, and the study was promoted through the services and through regional tv and radio news and use of the hospital's internal newspaper.

Information was collected via structured interviews and questionnaires from the participants and/or their next of kin, caregivers or support person. The questionnaires were filled out either at the hospitals research unit, in the participants' home, at another preferred location or by telephone. Information regarding the level of ID and other health conditions was confirmed by the participant's medical record (hospital or general practitioner).

Comprehensive information sheets were provided to all potential participants, including an easy-read version. Informed consent was obtained from each individual or his or her legal representative. The study was approved by the Committee for Medical

Research Ethics, Health Region North (2017/811) and the data protection officer at UNN and St. Olavs Hospital. The trial is registered in Clinical Trials with identification number NCT03889002.

Participants

Potential participants had a verified diagnosis of ID according to the International Statistical Classification of Diseases and Related Health Problems-10 criteria (WHO 2019), were age 16 years or older and living in the defined areas.

There were no predefined exclusion criteria, but some individuals were excluded because circumstances made it hard to obtain valid information or the ID diagnosis was withdrawn. Information about eligible nonparticipants was available only in the northern region, which included 266 eligible individuals and 140 participants, for a participation rate of 53%. The 140 participants were younger with mean age 35.3 (SD 14.1) versus mean age 42.3 (SD 15.9) in the 126 eligible nonparticipants ($P < 0.001$), while gender was similar across the two groups. In the middle part of Norway, there were lower participation rates, resulting in a sample of 74 participants with similar distribution of age and gender as in the north.

The degree of ID was categorised as mild (IQ 50–69), moderate (IQ 35–49), severe (IQ 20–34) or profound (IQ < 20) (WHO 2019). For eight individuals, the degree of ID was determined from information about adaptive functioning in cooperation with specialised ID health staff (Tassé *et al.* 2019).

Participants' living conditions were categorised as living alone, living with family or living in apartments attached to services (Molden *et al.* 2009). In Norway, adults with ID mainly reside in individual apartments where they receive services from the municipalities as needed. Some lives independently, while others live in clustered apartments with shared housing areas.

Multimorbidity

This study defined multimorbidity as one or more physical health conditions in addition to the ID-diagnosis (WHO 2016). Diagnoses of Down's syndrome, autism and cerebral palsy were not defined as physical health conditions. Mental health

conditions were not included in this operationalization.

The internationally developed POMONA-15 (P15) health indicators (Perry *et al.* 2010) were used for the assessment. The P15 is an assessment battery that was developed by a partnership of 13 EU member states to assess health inequity for adults with ID. Through an extensive literature search, a set of health indicators were derived and tested in the field. Indicators were selected if they were appraised as important, useful, measurable and if resulting data would enable comparisons between the health of people with ID and that of the general population (van Schroyen Lantman-de Valk *et al.* 2007; Perry *et al.* 2010). The health questions asked were ‘Did you ever have this disease, and do you have it now?’ A physical health condition was registered if the participants had the condition during the last year or as a chronic condition. The list of diseases in the P15 questionnaire were asthma, allergy, diabetes, cataract, hypertension, heart attack, stroke, chronic obstructive pulmonary disease/emphysema, arthritis (osteoarthritis/rheumatoid arthritis), osteoporosis, peptic ulcer, cancer including leukaemia, migraine or frequent headaches, constipation, thyroid disease, epilepsy and other diseases. Other frequent conditions registered were skin conditions and musculoskeletal disorders. Oral problems were registered when participants indicated pain in either the mouth or teeth.

Perceived health

Perceived health was rated by either the participant with ID, in collaboration with a family member or staff support person, or by a close representative alone. The question, ‘How is your health in general?’ had five response options: (1) very good, (2) good, (3) fair, (4) poor and (5) very poor. This same question has been used in general population studies (Wu *et al.* 2013; Bennie *et al.* 2017) and other studies of people with ID (Cocks *et al.* 2017; Kinnear *et al.* 2019). As previously reported (Cocks *et al.* 2017; Kinnear *et al.* 2019), the variable was dichotomized into good health (very good or good health) or poor health (fair, poor or very poor health).

Motor function

The Gross Motor Function Classification System (GMFCS) classifies gross motor functioning into levels 1–5, with lower scores indicating better function. The GMFCS was developed for children with cerebral palsy (Palisano *et al.* 1997), has high interrater reliability (McCormick *et al.* 2007) and has been used in studies of adults with ID (Dijkhuizen *et al.* 2018). Individuals with motor function level 1 may have limitations in advanced motor skills; level 2 usually require stair railings, walk unassisted, but may occasionally use assist devices; level 3 require walking assist devices inside and usually outside and levels 4 and 5 usually require a wheelchair for mobility.

Lifestyle factors

The lifestyle factors included physical activity, weight and smoking. Smoking was measured with the question ‘Do you smoke?’ and dichotomized into yes or no. The amount of physical activity was measured with the question; ‘In how much of your leisure time have you been physically active in the last year?’ The four response categories are (1) ‘Participating in hard training or sports competitions regularly more than once a week,’ (2) ‘jogging and other moderate sport or heavy gardening for at least 4 hour each week,’ (3) ‘walking, cycling or other forms of light exercise at least 4 hour a week,’ or (4) ‘reading, tv or other sedentary activities.’ The question has been used in the general population (Grimby *et al.* 2015) and in European health indicator studies of individuals with ID (Haveman *et al.* 2011). In addition, the two questions ‘Do you work out enough to get sweaty at least once a week?’ (Perry *et al.* 2010) and ‘Are you physically active for at least 30 minutes each day? (e.g., walking with faster heart rate),’ were used based on national recommendations from the Norwegian Directorate of Health in 2019. Both questions have the following response categories: no, yes and cannot answer. Body mass index (BMI) (Bailey and Ferro-Luzzi 1995) was categorised as underweight (BMI < 18.5), normal weight (BMI ≥ 18.5–24.9), overweight (BMI ≥ 25.0–29.9) or obese (BMI ≥ 30.0).

Data analysis

All analyses were conducted using IBM SPSS Statistics for Windows Version 26.0.

To investigate associations between levels of ID and physical health conditions as well as lifestyle factors a one-way analysis of variance was used for continuous variables and the χ^2 test for categorical variables. When there were few cells in the crosstabs, the results were checked with Fishers' exact test.

Variables associated with dichotomised good or poor health ratings as the dependent variable were investigated by logistic regression analyses. The effect sizes of the predictors are given as odds ratio (OR) with 95% confidence interval.

A series of univariate (unadjusted) logistic regression analyses were performed, using the independent variables age (scale), gender (male/female), Down syndrome (yes/no), autism (yes/no), cerebral palsy (yes/no), numbers of physical health conditions (scale), GMFCS (ordinal scale 1–5), level of ID (ordinal scale 1–4), BMI categories (underweight/normal/overweight/obese), BMI (scale), physical activity level (ordinal scale 4 levels), physical activity sweaty (yes/no) and physical activity at least 30 min per day (yes/no). Multivariate logistic regression analyses were then performed. Only variables that were significant ($P < 0.05$) in unadjusted logistic regression analyses were included, and the enter method and backward removal of insignificant variables were applied, always adjusting the multivariate models for age, gender and level of ID. The level of significance was set at $P < 0.05$. In the exploratory studies of the impact of lifestyle factors on perceived health, when adjusting for other significant predictors, we decided to retain lifestyle factors with $P < 0.10$ in the final model. Multicollinearity was checked between independent variables with 0.7 as cut-off value. The degree of pseudo-explained variance was reported according to Nagelkerke R^2 , while the Hosmer and Lemeshow test was used to investigate model fit of the final model.

Results

Participant characteristics

A total of 214 participants [56% men, mean age 36.1 (SD 13.8) years] were included. The level of ID was

mild (38%), moderate (26%), severe (24%) profound (8%) and unknown (4%). The 211 participants rating their health, reported it as either very good (33%), good (40%), fair (19%) or poor (8%). No one rated their health as very poor. Characteristics of the participants are presented in Table 1.

The registered physical health conditions within the whole sample and in relation to level of ID are

Table 1 Population characteristics ($N = 214$)

Characteristic	Total ($N = 214$)
Gender, n (%)	
Men	119 (56)
Women	95 (44)
Age (year), mean (SD)	36.1 (13.8)
median (range)	32.5 (16–78)
Level of ID*, n (%)	
Mild	82 (39)
Moderate	56 (26)
Severe	50 (24)
Profound	17 (8)
Unknown	9 (3)
Down syndrome, n (%)	40 (19)
Autism diagnosis, n (%)	48 (23)
Cerebral palsy, n (%)	24 (11)
Living condition, n (%)	
Lives independently	25 (12)
Lives with family	41 (19)
Own apartment attached to family house	2 (1)
Group home with care	146 (68)
Life style factors, n (%)	
Physical activity level	
Sedentary	95 (44)
Low level	92 (43)
Moderate level	15 (7)
High level	8 (4)
Weight, n (%)	
Underweight	18 (9)
Normal	62 (32)
Overweight	60 (31)
Obese	55 (28)
Smoking, n (%)	6 (3)
Respondents	
Adult with ID alone	(3)
Adult with ID and support person	(46)
Support person only	(51)
Support persons	
Family member	(64)
Healthcare professional	(34)
Other	(2)

*ID, intellectual disability.

presented in Table 2, as well as data for comparison with Folch *et al.* (2018). The mean number of physical health conditions was 2.1 (SD 1.5), and the frequency for multimorbidity was 79%. The most frequent health conditions were weight disorders (underweight/overweight/obese) (68%), visual problems (43%), allergy (32%), epilepsy (26%), oral problems (25%) and constipation (23%). Obesity, hypertension and visual aids were more frequently observed among individuals with mild ID than in

those with severe/profound ID. Very few participants smoked (3%). Autism, epilepsy and constipation were significantly more prevalent in individuals with severe and profound ID than in those with less severe ID levels.

Lifestyle factors

As seen in Table 2, the levels of physical activity were consistent across the three groups of ID. Over half of

Table 2 Physical health conditions and lifestyle factors in relation to level of intellectual disability in 205 participants

Characteristic	Level of ID, N = 205			P value	Whole cohort N = 214, Folch <i>et al.</i> (2018)	
	Mild ID N = 82	Moderate ID N = 56	Severe/Profound ID N = 67		%	et al. (2018)
Age years, mean (SD)	34.1 (12.5)	34.9 (14.0)	38.5 (14.8)	0.126	36.1 (13.8)	42.6 (15.3)
Autism (%)	14%	21%	35%	0.007	23%	18%
Downs syndrome (%)	6%	37%	18%	<0.001	19%	
Physical health condition, numbers of physical conditions, mean (SD)	2.0 (1.8)	1.9 (1.8)	2.1 (1.5)	0.718	2.1 (1.5)	
Frequency multimorbidity, one physical health cond.	78%	79%	84%	0.652	79%	
Allergy (%)	34%	29%	34%	0.800	32%	10%
Epilepsy (%)	20%	18%	40%	0.004	26%	31%
Constipation (%)	15%	20%	38%	0.004	23%	31%
Thyroid disorders (%)	8%	18%	8%	0.128	10%	10%
Migraine/headaches (%)	24%	9%	20%	0.111	15%	11%
Asthma (%)	11%	4%	4%	0.155	7%	3%
Diabetes (%)	7%	9%	1%	0.172	6%	7%
Cataracts (%)	4%	12%	2%	0.021	6%	9%
Hypertension (%)	13%	2%	2%	0.004	6%	12%
Skin conditions (%)	10%	11%	15%	0.598	12%	17%
Oral problems (%)	17%	24%	40%	0.011	25%	57%
Musculoskeletal disorders (%)	28%	16%	30%	0.167	25%	
Visual aids (%)	60%	46%	21%	<0.001	43%	
Hearing aids (%)	6%	4%	10%	0.308	7%	
Physical activity level (%)						
Sedentary	48%	45%	44%	0.899	44%	
Low level	38%	42%	50%	0.331	43%	
Moderate/high	15%	13%	6%	0.270	11%	
Sweaty at least once a week (%)	60%	45%	31%	0.002	45%	
30-min activity each day (%)	59%	63%	52%	0.632	58%	
Body mass index (BMI) (%)						
Underweight	7%	8%	11%	0.621	9%	
Normal	20%	35%	43%	0.002	32%	
Overweight	35%	31%	26%	0.483	31%	
Obese	38%	27%	19%	0.026	28%	

BMI, body mass index; ID, intellectual disability.

Prevalence of physical health conditions is given for the whole cohort ($n = 214$), in comparison with the study of Folch *et al.* (2018). Physical health conditions with prevalence above 5% are presented.

the participants (54%) reported, they did not exercise enough to get sweaty once a week. The group with mild ID (60%) were twice as likely to get sweaty at least once a week as the group of severe/profound ID (31%) ($P = 0.002$). In total, 58% of the participants reported being physically active for at least 30 min per day.

Normal BMI was more common among the group with severe/profound ID (43%) than in those with

moderate (35%) or mild (20%) ID. Obesity was most common in the group with mild ID (38%) (Table 2).

Variables associated with perceived health in univariate logistic regression analysis

More than 70% of the participants rated their perceived health as good. As shown in Table 3, women rated their perceived health worse than men

Table 3 Factors associated with perceived health in univariate and multivariate regression analyses ($n = 211$)

Characteristic	Univariate			Multivariate				
	Good health N = 154	Poor health N = 57	Unadjusted OR	95% CI	P	Adjusted OR	95% CI	P
Age, mean (95% CI)	35.1 (32.9–37.2)	38.5 (34.8–42.2)	1.02	1.00–1.04	0.107	0.99	.96–1.02	.538
Gender, <i>n</i> (%)								
Men (<i>n</i> = 117)	94 (61)	23 (40)						
Women (<i>n</i> = 94)	60 (39)	34 (60)	2.32	1.25–4.31	0.008	2.40	1.13–5.09	.023
Syndromes and comorbidity, <i>n</i> (%)								
Downs syndrome	27 (17)	13 (23)	1.40	0.660–2.93	0.387			
Autism	39 (26)	9 (16)	1.82	0.82–4.0	0.140			
Cerebral palsy	16 (10)	8 (14)	1.41	0.57–3.95	0.461			
Numbers of physical health Conditions, mean (95% CI)	1.6 (1.4–1.8)	3.0 (2.4–3.5)	1.62	1.33–2.0	<0.001	1.55	1.22–1.97	<.001
Motor function, GMFCS, <i>n</i> (%)								
Level 1	101 (66)	20 (35)						
Level 2	29 (19)	26 (46)						
Level 3–5	24 (16)	11 (19)	1.37	1.05–1.80	0.020	1.52	1.04–2.22	.030
Level of intellectual disability, <i>n</i> (%)								
Mild	56 (38)	24 (44)						
Moderate	40 (27)	15 (28)						
Severe/profound	52 (36)	15 (28)	0.83	0.60–1.14	0.258	.65	.42–.99	.047
BMI categories								
Underweight	14 (10)	4 (8)	1.30	0.40–4.10	0.672			
Normal	50 (35)	11 (22)	2.1	0.93–4.18	0.075			
Overweight	39 (27)	20 (39)	0.59	0.30–1.15	0.120			
Obese	39 (27)	16 (31)	0.83	0.41–1.73	0.60			
BMI scale, mean (95% CI)	26.6 (25.6–27.7)	27.5 (25.7–29.2)	1.0	0.97–1.10	0.436			
Physical activity level								
Sedentary	59 (38)	34 (60)						
Light	71 (46)	20 (35)						
Moderate/high	20 (13)	3 (6)	1.76	1.10–2.81	0.017			
Physical activity, sweaty, <i>n</i> (%)	79 (52)	17 (31)	2.45	1.27–4.72	0.007			
Physical activity 30 min/day, <i>n</i> (%)	92 (66)	22 (40)	2.88	1.51–5.47	0.001	2.02	0.935–4.37	0.073

BMI, body mass index; CI, confidence interval; GMFCS, Gross Motor Function Classification System; OR, odds ratio.

(Poor health: 36% women vs. 20% men). Participants with a higher number of physical health conditions were more likely to score poor health ($P < 0.001$). Worse motor function was associated with poor perceived health. In the unadjusted analysis, poor perceived health was associated with lower physical activity level on the four-level scale ($P < 0.05$), not being sweaty at least once a week ($P < 0.01$), and not being physically active at least 30 min a day ($P < 0.001$).

Variables associated with perceived health in multivariate logistic regression analyses

In the final model of the binary logistic regression analysis (Table 3), female gender (OR 2.4, $P \leq 0.05$), level of ID (OR 0.65, $P \leq 0.05$), numbers of physical health conditions (OR 1.6, $P < 0.001$) and lower motor function (OR 1.5, $P < 0.05$) were significant explanatory variables for poor perceived health, with a tendency to independently impact failure to achieve 30 min of daily physical activity (OR 2.0, $P \leq 0.07$). The Hosmer and Lemeshow test indicated a good model fit ($\chi^2 9.34$, $df = 8$, and $P = 0.314$). The Nagelkerke R^2 was 0.285.

Discussion

This study explored lifestyle factors and multimorbidity as predictors for perceived health in a community-based sample of adults with ID. More than 70% of the participants reported their perceived health as very good or good, somewhat lower than the 88% found in the general population in Ireland (Darker *et al.* 2016) and the 78% reported in an Australian sample (Cocks *et al.* 2017) but higher than the 48% in individuals with ID in Scotland (Kinnear *et al.* 2019). The participants in our study reported better perceived health than those in the study by Kinnear *et al.* (2019), which may be due to a somewhat younger and healthier study population, unidentified health conditions or better financial circumstances (Emerson *et al.* 2016; Cocks *et al.* 2017).

As expected, in unadjusted analyses, significant associations were found between poor perceived health ratings and the number of physical health conditions, in addition to several indicators of physical activity levels. No relationship between

obesity and perceived health was observed. In multivariate logistic regression analyses, predictors were female gender, lower motor function, level of ID, and greater number of physical health conditions, while there was a tendency for physical inactivity to predict poor perceived health.

Multimorbidity and perceived health

The finding that a higher number of physical health conditions predict poor perceived health is consistent with that of previous research in the general population (Darker *et al.* 2016; Hetlevik *et al.* 2020). Although we did not find recent studies of perceived health in people with ID that included medical health conditions as a predictor variable (Cocks *et al.* 2017; Kinnear *et al.* 2019; Jin *et al.* 2020), our finding was not unexpected, as adults with ID have markedly poorer health than nondisabled peers on self-rated health (Kinnear *et al.* 2019) as well as multimorbidity (Kinnear *et al.* 2018).

The reported mean of two health conditions in this cohort was lower than that reported in existing research literature (McCarron *et al.* 2013; Folch *et al.* 2018; Kinnear *et al.* 2018). This could be due to a younger study population, that mental health conditions were not included, the use of a fixed list of diseases and no physical examination to reveal unidentified conditions. The selection of a young study population was probably the result of easier recruitment because of more support from family members than in older individuals, which were more dependent on assistance from staff. On the other hand, the occurrence of 79% with at least one physical condition is higher than the 61.5% found in the representative study by Cooper *et al.* (2015). To include mental health would possibly strengthen the association between higher level of health conditions and lower perceived health (Sigurdardottir *et al.* 2019).

Multimorbidity has been reported to be independently associated with severe/profound ID (Hermans and Evenhuis 2014; Folch *et al.* 2018; Tyrer *et al.* 2019), a finding that was not confirmed in the present study. This discrepancy could be due to the fact that Tyrer *et al.* (2019) used a definition that included mental health disorders and required two or more chronic conditions in addition to ID. Epilepsy and constipation are significantly more prevalent in

adults with severe/profound IDs in this study, which is in line with the findings of Kinnear *et al.* (2018) and Tyrer *et al.* (2019). Autism was also more prevalent in the group of severe/profound ID, which differs from a Canadian study by Bryson *et al.* (2008) but is consistent with the findings of Folch *et al.* (2018).

Jin *et al.* (2020) investigated the association between levels of ID and perceived health and found a significant association in unadjusted analyses, in accordance with our study. In the present study, the level of ID was a significant predictor of perceived health in the multivariate analyses but with a low effect size (OR.65, $P < .05$). The fact that mobility is often adjusted for in health studies of adults with ID (Tyrer *et al.* 2019; Jin *et al.* 2020) is supported by our finding of motor function as a predictor of perceived health. Studies including participants with cerebral palsy report perceived health and functional level decrease with age (Usuba *et al.* 2014; Benner *et al.* 2017).

Lifestyle factors and perceived health

Several indicators of physical activity were associated with better perceived health in unadjusted models, and in the adjusted model, 30 min of daily physical activity tended to impact perceived health ($P = 0.07$). Similarly, a moderate physical activity level was found to significantly predict perceived health in the studies by Jin *et al.* (2020) and Cocks *et al.* (2017). Although the questions used differ, the findings that more active participants were more likely to rate their health as good is consistent.

A previous study reported that adults with ID and obesity had lower perceived health than those with normal weight (Jin *et al.* 2020), which was not confirmed in the present study. These conflicting results could be due to the somewhat lower proportion of obese individuals in our sample than in the American sample or due to healthier individuals in the Norwegian study, despite the presence of obesity. An association between obesity and lower perceived health has been observed in the general population (Katya *et al.* 2013) and should be investigated further in adults with ID.

Demographics and perceived health

Men rated health better than women in the present study, which is consistent with the research of

Kinnear *et al.* (2019) but not confirmed in other studies (Cocks *et al.* 2017; Jin *et al.* 2020).

Multimorbidity is associated with female gender in people with ID (Cooper *et al.* 2015; Tyrer *et al.* 2019), while in the general population, gender differences in multimorbidity and perceived health are not consistent (Rizza *et al.* 2012; Wister *et al.* 2016; King *et al.* 2018).

The most consistent factor affecting overall health, whether measured subjectively or objectively, is reported to be age (Wister *et al.* 2016; Cocks *et al.* 2017; Kinnear *et al.* 2019). Increasing age showed borderline significance to multimorbidity in the study by Tyrer *et al.* (2019). In the current study, age was not a significant factor for overall perceived health, but this may be due to a relatively young study population.

Health promotion

In the investigated regions, regular health assessments of adults with ID are mainly implemented for people with specific syndrome diagnoses or health conditions. However, regular checks by GPs are recommended (Norwegian Directorate of Health 2018). People with ID require focused services from an early age (Cooper *et al.* 2015), with health promotion programmes that include physical activity and a healthy diet. This study indicates female gender as an independent risk factor for poor perceived health. In addition, the study implies the importance of physical activity programmes and possibilities for a healthy lifestyle for people with mobility problems. Health promotion with regular health checks and facilitating participation in physical activity should be prioritised for all adults with ID.

Strengths and limitations

First, a cross-sectional design precludes interpretation of causal direction. Secondly, selection bias must be taken into consideration when interpreting the results. Individuals included were identified because they received health or care services and results may not reflect the findings in other individuals with ID. Representativity analyses showed that participants had a significantly lower age than that of eligible nonparticipants. This selection could reduce the occurrence of physical health conditions and increase the level of perceived health.

However, the prevalence of specific health conditions was quite comparable with the findings by Folch *et al.* (2018). A possible limitation was that ratings of perceived health were performed by both individuals with ID and proxies (family members or staff), although there are satisfying correlations between self- and caregiver-health reports for subjective health in individuals with ID (Scott and Haverkamp 2018). The rating of perceived health may be affected by the simultaneous interview about health status.

One strength of the study was the collection of information of ID level from the participants' medical records. A further strength of the study was the inclusion of actual physical health conditions in addition to the ratings of perceived health, thereby enabling the adjustment for multimorbidity in the multivariate analyses.

Conclusions

Adults with ID with female gender, reduced motor function and more physical health conditions are at increased risk of lower perceived health and should be a focus of health promoting interventions. A lack of physical activity tends to negatively influence perceived health.

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Conflict of Interest

No conflicts of interest have been declared.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available to privacy or ethical restrictions.

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